CYSTOSCOPY AND UROGRAPHY

BY

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THIRD EDITION REVISED AND ENLARGED

WITH 338 ILLUSTRATIONS IN THE TEXT AND 15 COLOURED PLATES

BRISTOL JOHN WRIGHT AND SONS LTD

LONDON SIMPKIN MARSHALL (1941) LTD

1949

First Edition, 1927
Second Edition, May, 1936
Third Edition, May, 1949

PREFACE TO THE THIRD EDITION

THE last edition of *Cystoscopy and Urography* appeared in 1936 During the war all the copies of that edition were destroyed by raids on London and all the materials for a reprint suffered a similar fate when Messrs John Wright s publishing house was bombed The book has therefore, been unobtainable for a number of years As there seems to be a genuine demand for it, a third edition has been prepared and I trust that it includes recent advances and reflects modern thought The text has been carefully revised and much new material has been incorporated at many places throughout the book

The chapter on Urinary Tuberculosis has been largely rewritten and is preceded by one on the pathology of that disease At first sight this may seem a curious intrusion in a book on Cystoscopy and Urography Its inclusion arose from the difficulty I experienced in discussing the meaning of various tests without sketching in the background against which those tests must be interpreted and this was so lengthy as to be unmanageable within the chapter itself

A section on the punch operation for prostatic hypertrophy is contributed by Mr R H O B Robinson, this being an operation which I myself have not practised and I am fortunate to have the co operation of so able an exponent I tender him my sincere thanks for his contribution

The chapter on Bilharzia has been much enlarged and I have drawn freely on recent publications especially one by Mr Ogier Ward in the *Proceedings of the Royal Society of Medicine*

Mr Schranz, of the Genito urinary Manufacturing Co has kindly contributed two valuable paragraphs on some recent improvements in cystoscope lenses and has been ever willing to assist with any technical problems which I have referred to him

To Mr J B Lloyd chief pharmacist to the Manchester Royal Infirmary I am indebted for help in preparing some notes on the chemistry of Diodone and Iodoxyl and to Messrs Glaxo who have likewise assisted in this

Notes on the precystoscopic examination of a patient are introduced as an appendix

Plate XV is new and *Plate IX* has been made to include drawings of two additional ureters Sixteen of the illustrations used in the second edition have disappeared, but 66 new ones find a place Many of these are radiographs and urograms which should serve to strengthen this section of the volume Other work from Miss Dorothy Davison's clever hand, additional to that published in the second edition finds a place and is much appreciated and admired

I thank Mr Garland Fairhurst, F R I B A, for preparing the plan from which *Fig* 34 was taken

Dr J B Hartley has kindly made a number of prints from films used in my work at the Christie Hospital and has been helpful in several ways

I have to thank Dr Grieve for the use of *Fig* 212 A and Major Rhys Lewis for *Figs* 81, 83 To *The Lancet* and the *Liverpool Medico-chirurgical Journal* I am grateful for permission to reproduce *Figs* 269 and 130 respectively The *British Journal of Surgery* has allowed me to publish *Plate IX* and *Figs* 300–308, which are all from articles I contributed to that journal in October, 1947

The figures in Chapter XXVI are all borrowed and they were acknowledged in the previous edition, but courtesy calls for a fresh note *Figs* 319–323 are from an article by Dr Traut which appeared in *Surgery Gynecology and Obstetrics*, and they are charming examples of the work of Max Brodel *Figs.* 324, 325, 329, and 330 are from articles by the late Dr Lee Brown and are kindly lent by the *British Journal of Urology* whilst *Fig* 287 from the same journal is from a contribution by Mr D Morison

Once again I have consulted articles in the surgical press, too numerous to be individually mentioned

Finally it gives me great pleasure to put on record my indebtedness to my publishers who have invariably been courteous, co-operative, and attentive to the smallest detail The high quality of their work is manifest and I accord to them my warmest thanks

J B M

Manchester

April 1949

PREFACE TO THE FIRST EDITION

BELIEVING that there is a real need for a book on cystoscopy I have attempted the task It is several years since I conceived the idea and my first care was to provide myself with an artist to draw cystoscopic pictures Having trained such an artist to the point where he was starting to become useful to me I lost his services through ill health A few of his drawings are reproduced herein and a few more of his less mature efforts have been redrawn by Mr W Thornton Shiells of London Unable to face the training of a fresh draughtsman I approached Mr Thornton Shiells who kindly consented to travel to Manchester periodically cases of interest were collected for him and I have enjoyed a fair amount of fortune in being able to call up suitable material on the occasions of his visits Though I do not feel that the cystoscopic circles reproduced in this work call for any apology it is nevertheless certain that if I had been fortunate enough to have my artist within easy call I should have had a larger selection of drawings from which to choose I am greatly indebted to Mr Thornton Shiells for his unfailing cheerfulness in making so many long journeys and for his capable work

There are a large number of surgeons whose opportunities for using the cystoscope do not recur with sufficient frequency to make them skilled in its employment Their mistakes are usually trifling yet are sufficient to make shipwreck of their attempts In the hope of helping these I have entered into much detail when describing the technique of cystoscopy and it is possible that I have been over anxious to be explicit

I am indebted to Mr Cyril Nitch and Mr Jocelyn Swan for the loan of several pyelograms and to Drs Hyman Gilbert Thomas and Hinman of the United States of America for the use of *Figs* 64 66 and 67 respectively Messrs Williams and Wilkins have kindly permitted me to copy *Fig* 66 For the loan of the blocks of *Figs* 93 and 94 I have to thank Mr Canny Ryall and Mr Henry Kimpton Mr E D McCrea has read through the text carefully

and has offered helpful criticism To Mr Schranz, of the Genito-urinary Manufacturing Co., I have read several chapters on the cystoscope and from him have received valuable assistance particularly in the section on the optical apparatus To him also I am indebted for the drawings from which *Figs* 4 and 117 were prepared The Genito-urinary Manufacturing Co have kindly lent me many of the electros appearing in this work whilst Messrs Down Bros have supplied *Figs* 57 122 and 127 and Messrs Allen and Hanburys *Fig* 12 Finally, to my publishers I gratefully acknowledge my indebtedness for their unfailing courtesy and for the great energy and thoroughness which they have thrown into the production of my book

In preparing the text I have consulted works on cystoscopy by Nitze Casper. Ringleb Pilcher Marion and Heitz-Boyer, and Papin and works on pyelography by Braasch and Papin Articles in various journals, too numerous to be separately acknowledged, have also been referred to

The historical section derives largely from Nitze's text-book, and the arrangement of Chapter V was suggested by that of the corresponding chapter in Marion and Heitz-Boyer's work

The first section of Chapter X has previously been published in a slightly different form in the *British Medical Journal*

J B M

Manchester,
April 1927

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CYSTOSCOPY

CHAPTER I

HISTORICAL

EVEN from earliest times clinicians have been dissatisfied with the simple examination of the body surface and have been ambitious to inspect those hollow viscera which are accessible For this purpose special instruments became necessary To the ancient Hebrews the use of vaginal specula was known whilst expanding rectal specula were amongst the surgical instruments discovered in Pompeii Nevertheless for a long time such examinations remained limited to cavities communicating with the exterior of the body by wide orifices, such as the mouth vagina and rectum In no case does one find any reference to an attempt to inspect deep lying cavities like the bladder until comparatively modern times ' *

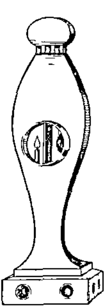

Fig 1 —
Bozzini s cystoscope
(*Redrawn from the original*)

The first attempts at the illumination of the bladder date back as far as 1804 when Bozzini (1773–1809) of Frankfurt, constructed a long tube which he passed down the urethra The extravesical end of this tube fitted on to a box containing a candle as a source of illumination At the back of the box the observer s eye was placed and a partition was so arranged as to shade the light of the candle from his eye Such was the first primitive cystoscope (*Fig* 1)

In 1826 Segalas (1792–1875) introduced a cysto urethral speculum which received little attention but a more successful attempt was made by Desormeaux a French surgeon who is sometimes referred to as 'the father of cystoscopy ' In 1853 he demonstrated his 'endoscope ' to the Parisian Academy and in 1865 published his work

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* Free translation from Nitze s *Lehrbuch der Kystoscopie* 2nd ed Berlin 1907

De l'Endoscopie et de ses Applications au Diagnostic et au Traitement des Affections de l'Urèthre et de la Vessie

The instrument made by Désormeaux (1815—82) was more complicated than its predecessors Its source of light was a gas lamp, and the rays from this collected by a lens, were reflected by a plain mirror into an endoscopic tube which passed into the urethra and bladder The observer's eye was placed behind a hole in the mirror It had, in fact many points in common with our modern anterior urethroscope The limitations of this instrument are obvious The light could never be adequate to give a decent picture of the vesical wall, and even if such a picture could be obtained, only a small portion of the fundus of the bladder could be brought into view Various other investigators, however, thought it worth while to use and develop Désormeaux's 'endoscope' Their efforts were directed mainly to the improvement of the illumination Thus Cruise, of Dublin and Furstenheim, of Berlin, substituted petroleum for the gas, whilst Stein adopted magnesium wire. In all cases, however, they followed Bozzini and Désormeaux in that they relied on an external source of light reflected down an endoscopic tube. Their results were necessarily poor, and their instruments did not come into general use One investigator, however, showed originality Bruck in 1867 attempted to illuminate the bladder by placing in the rectum a lamp containing platinum wire, which he rendered incandescent by means of an electric current, and around which he ran a current of water to avoid burning the rectal mucosa. This he used in combination with a urethral endoscopic tube, hoping by transillumination to obtain sufficient light to investigate the condition of the bladder His method also was a failure In these days of superior instruments it is interesting to look back sympathetically at the primitive attempts of these pioneers, and to realize how keenly they felt the necessity of obtaining a view, however imperfect, of the interior of the viscus

Matters stood thus in 1876 when Nitze (1848–1906) took up the problem His work culminated in the invention of a cystoscope which in its essentials is the instrument in use to-day From the commencement he foresaw that no advance was possible so long as external illumination was used, and that a light must be carried into the bladder itself exactly " as one takes a lamp into a room in order to light it At that time, of course, the Edison lamp had not been invented and Nitze had to devise a lamp himself After many experiments he selected platinum wire rendered incandescent by the electric current as the most suitable source of illumination It occupied little room, and was thus easily introduced into the bladder on the end of the cystoscope By it a clear and strong white light

could be obtained Against these advantages was to be placed the fact that it generated intense heat which would prohibit its use if it could not be controlled At first Nitze tried to cool the lamp with a current of air, but this proved unsatisfactory later he had resort to water cooling Two tubes ran throughout the length of the instrument and served to carry water to the beak where the lamp was situated (Fig 2) This method though clumsy proved fairly efficient Nevertheless the lamp remained the chief source of difficulty right up to the time when the Edison lamp was invented and adopted for use with the cystoscope Nitze was constantly working to improve his lamp and his methods of cooling it The one which he ultimately devised was contained in a metal case whose window was made of a piece of thinly scraped goose quill Inside this there was a glass bulb containing the platinum and between the glass and the goose quill water circulated to cool the lamp This remarkable lamp says Nitze was wonderfully efficient and durable, though the platinum wire frequently fused at the critical moment

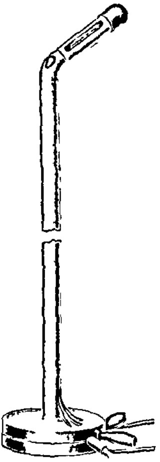


Fig 2—Nitze s first cystoscope Optical system terminal platinum filament lamp Note water cooling system (*Redrawn from the original*)

It was of little value to have introduced a light into the bladder if a larger part of the vesical wall could not be brought into view for hitherto only that portion of the viscus which lies directly opposite the end of the tube could be seen (*see Fig* 14) The examination would therefore have to be limited to a portion of the fundus and trigone of the bladder The solution of this problem came suddenly one day when Nitze was doing some microscopical work in Dresden Whilst changing the eye piece of a microscope he held it up to the window to see if it was clean and through it received the small inverted image of a neighbouring church tower The problem was solved With the assistance of a Dresden instrument maker he worked out a lens system which he introduced into the interior of his cystoscope This had the effect of increasing the field of vision and of bringing the object closer to the eye of the observer Even so only that portion of the bladder lying opposite the internal meatus could be inspected The instrument was in fact a direct cystoscope

The next stage consisted in the introduction of a prism at the end of the shaft One aspect of the prism looked out through a window cut in the side of the tube and its hypotenuse acted as a mirror to reflect the beams down the tube By this means a mirror picture of the whole of the bladder wall was obtained In order to make it as perfect as possible Nitze left Dresden for Vienna, where he collaborated with the well-known surgical instrument maker, Leiter. The first models produced in that city are known as the Nitze-Leiter cystoscopes In 1879 he demonstrated his inventions to the Vienna Medical Society where they received much approbation. However, the clumsiness of the lighting system and its water-cooling apparatus prevented the instrument from coming into common use even amongst the specialists of the day

The following year 1880 saw the appearance of the Edison lamp Nitze was somewhat shy of it in the first instance and, according to Casper thought it might explode in the bladder The honour of being the first to have a cystoscope fitted with a 'Mignon lamp belongs to von Dittel who had one made by Leiter But he had to wait until 1886 before it was found possible to construct a lamp sufficiently small and delicate for his purpose When Nitze saw it in use his fears disappeared and he realized that therein lay the salvation of his instrument Then the complicated platinum wire with its water-cooling apparatus disappeared, and the cool carbon-filament lamp solved the last and greatest of Nitze's difficulties The instrument thus completed was the same in principle as the one we use to-day; details have been altered and improved and additions have been made to it such as irrigating parts provision for ureteral catheterization and intravesical operating etc but the fundamentals of the optical and lighting apparatus remain

Thereafter the number of practitioners of cystoscopy rapidly grew, many of them anxious to add to the new diagnostic method Nitze himself participated fully in the subsequent progress and improvement of his instrument and its equipment, and was responsible for the invention of many of the accessories such as operating parts hot wire snares modifications of ureteric catheters and the like

CHAPTER II

THE CYSTOSCOPE

NUMEROUS varieties of cystoscope have been described, but all come under one of two headings *direct* or *indirect*

We have seen in the previous chapter that the first cystoscopes were of the direct pattern and that the indirect type evolved from these at a later date by the insertion of a prism in the optical apparatus A few surgeons, as for instance the followers of Kelly in America still prefer the direct cystoscope generally in the form of a simple endoscopic tube The sphere of usefulness of this instrument is limited to female urology The large majority of cystoscopists, however, now use the indirect instrument, as a more extensive and efficient inspection of the bladder is provided thereby As the present writer has little experience of direct cystoscopy and the coloured drawings in this book have been made with the aid of the indirect instrument the direct forms will not be described

Advantages of an Irrigating Model—In the first cystoscopes the telescope carrying the optical parts was built into the instrument and was irremovable but soon it was found possible to make a separate and removable telescope and the modern almost universally used irrigating cystoscope came into being When the optical apparatus of this instrument is withdrawn the sheath is converted into a catheter capable of serving for irrigation of the bladder This obviates the passing of more than one instrument for both preparation and examination It also makes it possible to change the vesical medium in the middle of an examination without removing the instrument which is advantageous when a bladder bleeds freely or when large quantities of pus are rapidly thrown into the bladder, either from the kidney or from the vesical mucosa or from some other source such as for instance a diverticulum or when debris is shed from the surface of a papilloma during diathermy In all these cases the medium becomes turbid and it is convenient to be able to change it quickly without removing the instrument When the urethra bleeds on instrumentation it becomes almost imperative to use an irrigating cystoscope for then clots of blood foul the prism window during introduction and obscure the field In the irrigating instrument the telescope can when thus soiled be easily withdrawn cleaned and re inserted whereas the removal of the whole instrument

is time-consuming and painful Furthermore the prism probably becomes fouled again on re-insertion, so that even then a satisfactory examination cannot be obtained

DESCRIPTION OF THE INDIRECT OR PRISMATIC CYSTOSCOPE (Examination Model)

The cystoscope is divisible for purposes of description into two main portions (I) *A Sheath containing the irrigating and lighting arrangements* (*Figs* 3 A 4), (II) *A Telescope containing the optical system* (*Fig* 3 B)

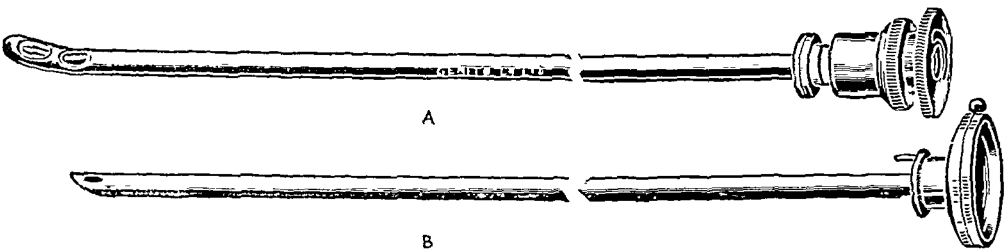


Fig 3—Examination cystoscope, irrigating pattern A, Catheter or sheath with lighting apparatus, B, Telescope

I. THE SHEATH, WITH ITS IRRIGATING AND LIGHTING ARRANGEMENTS

The sheath (*Fig* 3 A) is a hollow tube or catheter to which are attached —

1 The lighting equipment, consisting of (i) A pair of rings situated at the external or ocular end of the instrument for the reception of a detachable switch, (ii) A lamp at the vesical end, and (iii) A wire joining (i) and (ii)

2 A valve to prevent escape of bladder contents when the telescope is not in position

The sheath is about 10 to 12 in long, having a diameter corresponding to 21 on the Charrière scale It has two extremities, an inner or vesical extremity and an outer or ocular (*Fig* 4) The former is short, bent at an angle of 45° with the shaft and contains the female portion of a screw (A) for the reception of the lamp Centrally placed at the bottom of a small cup-shaped depression in the end of the cystoscope will be seen an insulated electric terminal (B) for contact with the wiring of the lamp. Immediately behind the angle at the vesical extremity is a small window or fenestra (C) cut in the concavity of the sheath beneath which the prism appears when the telescope is in place

A small metal cap (G) containing the lamp forms the beak of the cystoscope Its distal extremity is rounded whilst its proximal extremity ends in a screw for attachment to the vesical end of the

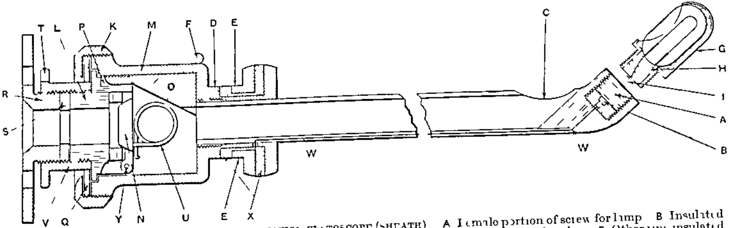
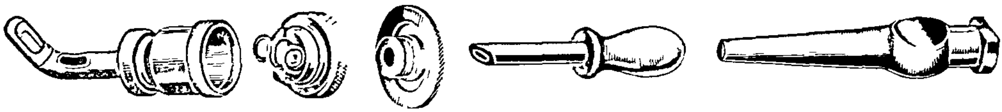


Fig. 4.—Longitudinal section of examination cystoscope (sheath). A Female portion of screw for lamp. B Insulated electric terminal. C Lens tray. D Metal ring for reception of coupler and in contact with valve chamber. E Other ring insulated from sheath by ebonite coating (X) but connected to B by wire (W). F Knob. G Metal cap of lamp. H End of lamp filament attached to hood. I Filament for contact with B. K Valve ring fixing valve (L). M Wall of valve chamber. N Hinged door (clapper). O Key. P Key way. Q Rubber washer (large). R Compression screw. S Rubber washer (small). T Slot for telescope pin. U Spring of clapper. V Valve collar. W Electric wire. X Ebonite or bakelite insulation for ring (E). Y Hinge of clapper.

cystoscope The lamp consists of an exhausted glass bulb which projects into a lateral orifice cut in the side of the metal cap When in position this orifice should be situated directly in front of the fenestra in the sheath, so that the telescopic field and the field of illumination may correspond It contains a metal filament of which one end (H) is soldered to the metal hood the current being conducted by the walls of the cystoscope to the external end of the instrument The other end of the filament (I) emerges centrally and makes contact with the metal terminal (B) observed at the vesical extremity of the sheath It is produced outside the lamp for a short distance in order to ensure good contact.

At the external end of the cystoscope the sheath proper is surrounded by two rings of metal which make spring contact with the terminals of the switch The ring (D) lying in apposition with the valve chamber (M) is in metallic continuity with that structure, and through it passes the return flow of the electric current The other



A B C D E

Fig 3 —A, Cystoscope sheath (note the key in valve chamber and the key-way cut in valve), B, Valve, valve collar, and valve ring (these cannot be taken apart except by the makers), C, Compression ring, D, Faucet, and E, Syringe nozzle

ring (E) is insulated from the sheath by a seating of ebonite or bakelite (X), but is connected to a fine insulated wire (W) running in the floor of the catheter and terminating at the vesical end of the instrument in the metal terminal (B) already observed there

All the parts within the cystoscope concerned in the conduction of the current have now been described and it may be advantageous to trace the complete circuit Commencing with the metal ring (E), which is situated farthest from the ocular we may imagine the current running along the wire (W) in the floor of the sheath until it reaches its metal terminal (B) This terminal makes contact with the central filament of the lamp (I) and the current running through the bulb reaches the metal case and travels via the wall of the sheath to the ring (D) which as before stated, is part of the body of the cystoscope The two rings, of course bring the cystoscope into connection with a source of current by means of the switch which will be described later

Immediately behind these two rings the catheter undergoes a generous expansion (valve chamber) (M), in order to accommodate the valve and its accessories The enlargement is about an inch in length At its distal edge is mounted a small knob (F) so placed that it will indicate the position occupied by the fenestra when the

cystoscope is in the bladder By reference to this knob the surgeon is kept informed as to what area of bladder is under inspection

The ocular end of the instrument is closed by a valve fixed in position by a screw cap (K) It controls the escape of vesical fluids when the telescope is not in place The valve (L) is shown in *Fig* 5 B It is a thick walled tube so shaped as to be accurately received into the valve chamber (*Fig* 5 A) of the cystoscope Its bore corresponds to that of the sheath and lies directly opposite the same A hinged door (clappet) opening from without inwards and regulated by a spring, closes this orifice when not in occupation either by the telescope or the faucet The clappet is hinged at its lowest point so that when the obliquely cut end of the telescope or faucet is correctly inserted its extremity encounters the free upper margin of the door and so easily opens it To ensure that the valve is accurately inserted a projection from the roof of the valve chamber fits into a groove on the upper surface of the valve The projection is known as the 'key' and the groove as the 'key way' A screw cap (valve ring) with an internal thread overlaps the extremity of the cystoscope and holds the valve in position Between the valve and the screw is a rubber washer

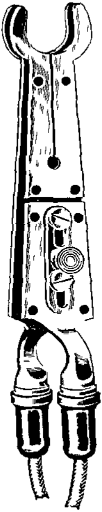


Fig 6 —The switch

Embracing the outer part of the valve (L) is a short wide flanged tube (valve collar) (V) with an internal screw thread This projects through the valve ring (K) and on the upper margin of its flange is a slot (T) for the reception of a pin attached to the telescope (*Fig* 3 B) This slot and pin maintain the telescope in position so that it does not rotate away from the window (C) in the sheath The outer portion of the tube accommodates the compression screw (R) and between this and the end of the valve is a second and smaller rubber washer (S) The washer and the compression screw are centrally perforated for the transmission of the telescope and their bore corresponds to its diameter When the compression screw (R) is tightened it compresses the washer against the valve so that it bulges towards the sides of the telescope and renders the junction watertight During the insertion of the telescope it is very important that this compression screw be released otherwise force will have to be used to overcome the resistance of the washer This is one of the most fertile causes of a bent telescope (see page 29)

The *switch* is shown in *Fig* 6 It consists of two plates of metal separated by a layer of insulating material At one end two concave rings make spring contact with the cystoscope At the other end the plates are attached to two cords responsible for uniting the cystoscope to a source of electrical energy One of the plates is divided about its centre and the two halves are insulated The connection between these two halves can be re-established by means of a slide The position of the slide determines the passage or otherwise of the current

The function of the *faucet* (*Fig* 7) is to open the valve for evacuation or irrigation of the bladder It is a tube about 2 in. long, cut obliquely at one end to facilitate the depression of the valve The other end is somewhat expanded and has a conical bore, so that it will make watertight connection with the nozzle of the bladder syringe Some workers draw on to its end an intermediate piece of rubber tubing to act as a connection with the syringe As the direct junction with the syringe is quite satisfactory and easy to work this is unnecessary, and it causes the introduction of a needless amount of air which undesirably augments the size of the air bubble and so obscures the bladder vault Alternatively the two-way *irrigating* tap shown in *Fig* 8 may be preferred, but the writer finds the simpler device seen in *Fig* 7 more satisfactory

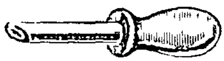


Fig 7 —The faucet

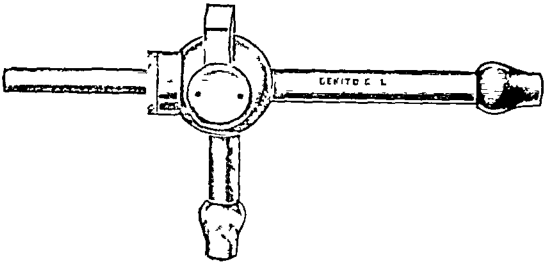


Fig 8 —Two way irrigating tap

II TELESCOPE AND OPTICAL ARRANGEMENTS

The telescope (*Fig* 9) contains the optical apparatus of the cystoscope, the function of which is to transport the vesical picture to the eye of the observer in such a form that it will produce on his retina an image of sufficient magnitude and brilliance to be appreciated easily In the earlier instruments the telescope was permanently built into the cystoscope but in modern practice it is separate from the sheath It consists of a thin tube in which is contained a series of lenses whose number varies according to the design In the direct cystoscope the vesical picture gains admission through a terminal opening In the indirect instrument it enters through a lateral opening or fenestra underneath which is situated a right-angled prism to divert rays through 90 along the telescope With the aid

of an appropriate system of lenses these rays ultimately reach the observer's retina

The maker of these instruments is severely limited in the amount of space at his disposal, and all materials have to be used with most rigid economy of dimension It follows that the telescope tubing is

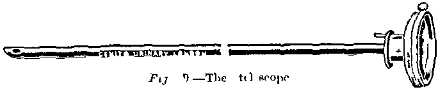


Fig 9 —The telescope

very thin and therefore easily bent It demands the greatest gentleness in use as the least distortion will obviously throw the long lens system out of alinement with disastrous results These facts should be impressed on hospital sisters or any others on whom devolves the care of these instruments for bending is a frequent occurrence and is quite avoidable if proper precautions are taken

In the original Nitze cystoscope the lens system was a direct one there being no reflecting device and the inlet of the system being terminal The direct view is retained in certain posterior urethroscopes to day of which the Joly model may be cited as an example

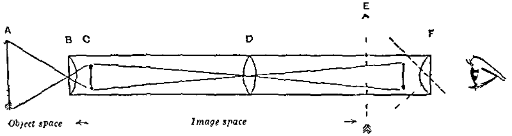


Fig 10 —The lens system of Nitze's cystoscope A Object B Objective C Real inverted diminished image D Central inverting or transporting lens E Upright magnified virtual image F Ocular

It is convenient to study the lens system in these simpler forms before taking into account the complications produced by the addition of a prism In Nitze's original instrument (*see Fig* 2) there were three lenses the objective at the vesical end a central or inverting lens and an ocular (*Fig* 10) The function of the objective was to concentrate within the small dimensions of the telescope the rays diverging from the object These were brought to a focus behind the objective as a real inverted diminished image and the rays were then taken up by the middle or inverting lens and focused in front of the ocular as an upright image of the same small dimensions as the *previous image* As this corresponded in size to the bore of the containing telescope

(in modern instruments about 4 mm., in Nitze's rather more) it became necessary to magnify it in order that a clear retinal picture might be obtained. The image was therefore amplified by the ocular to such a degree as experience proved most serviceable (*see* page 15). An upright magnified virtual image resulted.

The principles of this simple system have been retained in modern cystoscopes though they have evolved considerably. All who employ these beautiful instruments should be acquainted with a few of the more important optical considerations governing the construction of a good telescope, and an elementary description will therefore be given.

Objective.—If one looks through the ocular whilst the objective faces a bright surface, a circle of light will be seen. This circle is of the same size whether the surface is distant or close, whether it is the sky or an adjacent sheet of paper. It is known as the apparent visual field or the apparent or virtual image, in contrast with the external or actual field of view, which in the foregoing illustration was represented by the sky or the sheet of paper. It will easily be appreciated that the former of these is of constant dimension, whilst the linear extension of the latter is proportional to its distance from the objective. Thus if the objective is close to the object the external field will be of practically the same size as the lens itself, whilst when the instrument is held towards the sky, the external field is infinitely distant and is therefore of infinite size. In Nitze's instrument objects at all distances were equally in focus,* the system had therefore a universal focus. This is also true within certain wide limits of the modern cystoscope.

Reference to *Fig.* 10 will indicate how the object space is constituted.† It corresponds to a cone whose apex is at the central point of the objective and whose base is at infinity. The angle formed

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* When objects seen through an optical instrument at widely varying distances are all in uniformly good focus, that instrument is said to have a 'great depth of focus' or 'great penetration'. This feature depends on the small diameter of the emerging pencil of light, but it is for this reason incompatible with good transmission of light, which depends on a large emerging pencil (*see* page 18). Light transmission has been greatly improved in recent years by means that will shortly be outlined, and there has therefore been some loss of 'penetration' in that objects beyond a certain distance from the objective are not in perfect focus. This, however, is not important provided that the cystoscopist himself has a normal range of accommodation, for he can then compensate with ease any imperfection, and indeed a normal eye does not perceive the faulty focus. Moreover, penetration is perfect for objects situated within the first few inches from the objective, and this is the only part of the range employed in intravesical work.

† The term 'object space' denotes the space in front of a lens or lens system in which the objects are situated, in contradistinction to the 'image space' on the opposite side of the lens where the real image of the object is formed (*Fig.* 10).

at the apex varies in size and depends on the focal length of the objective and the internal tube diameter (usually about 3.8 mm or $\frac{1}{8}$ in)

If a penny is placed on a sheet of white paper and the end of the telescope is alternately approximated and withdrawn it will be noticed that the penny appears to vary in dimensions being large when the object we approaches it and becoming smaller when it recedes (*Fig* 11) At close quarters it cannot be contained in the apparent visual field but as distance increases a circle of white surrounding the penny appears and enlarges whilst the penny appears to diminish Similar phenomena occur in the bladder and are illustrated in the case of a calculus by *Fig* 12

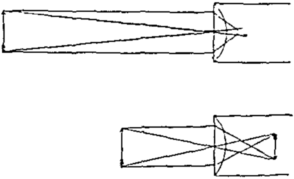


Fig 11 — Diagrams showing effect of distance on the size of the resultant image

The normal field of view for which the cystoscope is made is the bladder and here the distances are limited by the size of that organ

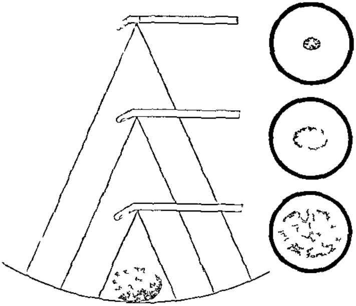


Fig 12 — Examination of vesical calculus from three different altitudes showing the effect of distance on magnification

It is uncommon to have to inspect the bladder wall from a distance greater than 50 mm (say 2 in) Even for the upper parts of the

organ, and in cases of dilatation, it is usually possible to bring the beak of the instrument within that range

At a given distance (say, 25 mm or 1 in.) and with a given diameter of lens tube, the extent of the field of vision will be determined by the focal length of the objective lens; the shorter the focal length the larger the field (*Fig* 13) If no lenses are employed, as in a simple endoscopic tube (e g, Kelly's), the extent of the field of view is equal to the lumen of the tube (*Fig* 14) Whilst it is desirable to have a good field of vision, it should be appreciated that as this increases in extent, other things being equal, so magnification and definition diminish, and as these are very important features of the cystoscope, they must not be lightly renounced. They could, of course, be recovered at the other end of the instrument by increasing the strength of the ocular, but this again would lead to a reduction in the brightness of the image, which also must not be sacrificed (*see* page 17) The objective has to be designed to effect a compromise amongst these three competing

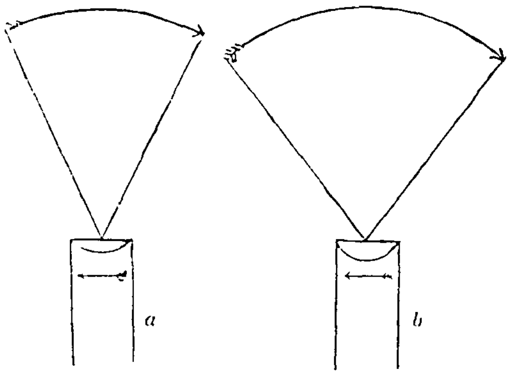


Fig 13.—*a*, Objective with small angle, therefore small field of view, good magnification and illumination *b*, Wider angled objective, large external field, loss of magnification and illumination

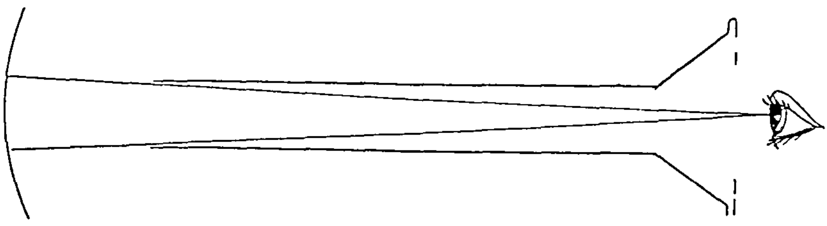


Fig 14.—Inspection through Kelly's tube The field of view corresponds in size to that of the lumen of the tube

factors—namely a large field of view, good magnification and definition and adequate illumination As a rule the focal length adopted lies between 3.5 mm. ($\frac{1}{8}$ in.) and 6.5 mm ($\frac{1}{4}$ in.)

Let us examine the properties of the instrument, adopting the simplest possible figures in order to avoid complicated calculations (*Fig* 15) Let us therefore take the focal length of the objective as $\frac{1}{4}$ in., it will then be found that with the object at a distance of 1 in. the external field will also have a diameter of 1 in. This must be reduced to the size of the interior of the telescope, say $\frac{1}{8}$ in., so

that a real inverted image one eighth the size of the object will be formed. If we now take an object 2 in. distant the diminution will be proportionately greater a reduction of 16 times taking place.

Inverting Lens.—The image is transferred to the ocular unchanged in size, the inverting lens system playing a passive role so far as any alterations in the proportions of the image are concerned.

Ocular.—The minute image thrown in front of the ocular would be invisible to the eye and must be enlarged. This is the function of the ocular and by it an enlarged, upright, virtual image is formed. It is customary to use a lens of such power that it increases the image to a greater extent than the objective lens has previously reduced the external image. A lens giving a magnification of between 10 and 20 times is generally employed. In continuing the foregoing illustration it will be convenient if an ocular which has double the power of the objective is adopted. This represents with fair accuracy the relative capacities of these units adopted in many cystoscopes. As the objective had a focal length of $\frac{1}{4}$ in. the ocular will now have one of $\frac{1}{8}$ in. and will magnify the image by 16 times. It will be remembered that the objective had to reduce a field situated 1 in. away by 8 times and one situated 2 in. away by 16 times in order to condense them within the telescope (Fig. 15). It will now be seen that the 1 in. field after

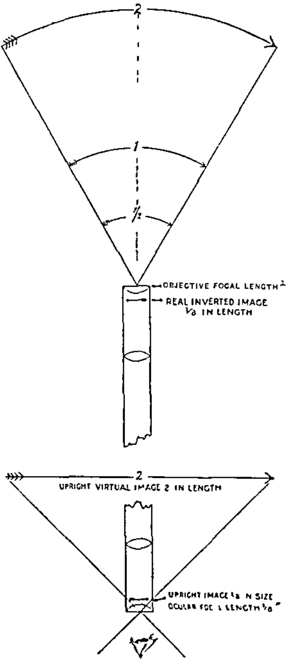


Fig. 15.—Diagram illustrating the proportions of the telescope.

magnification by 16 diameters at the ocular, will be presented to the observer's eye with an ultimate amplification equal to twice its actual size, whilst a field which is 2 in removed from the objective will be presented with its correct measurements *

The nearer the objective approaches the object, the greater will be its magnification, and this is important in bladder examination, for there are areas of that viscus of which it is impossible to get a distant view (save perhaps by means of a retrograde cystoscope) The vesical neck is, of course, in actual contact with the prism during inspection, and those portions of the trigone which lie nearest to the meatus must always undergo high magnification (up to 8 or 10 diameters) and this must be allowed for when interpreting bladder pictures or any pathological lesion

Beyond a distance of 2 in (50 mm) the bladder image would suffer diminution In actual practice the wall of the bladder is rarely as much as, and practically never more than, 2 in. away from the prism, so that the object is almost always magnified to some extent A convenient and easy distance at which to conduct an examination (canonical distance) is about ¼ in to 1 in from the bladder wall, the virtual image then having approximately twice the size of the actual object For the more accessible portions of the viscus (trigone, ureteric orifices lateral walls, etc) it is easy to increase the magnification by making the beak of the instrument approach the mucosa. With experience it is possible to judge the degree of approximation by noting the definition and magnification of the detail of the mucosa, and by other things such as the way that the light reaches the eye, a translucent effect being produced with the indirect cystoscope when working at close range (*see Fig* 64)

The cystoscope when held directly opposite to one of the walls of the bladder faces a concavity, each portion of which is roughly equidistant from its lens and is therefore similarly magnified If, however it is held obliquely opposite to one of the walls, those portions which are the nearer to the lens will be magnified to a greater extent than those which are more distant, and this will be more evident as the obliquity increases (cf *Fig* 22) It is well exemplified in the examination of the anterior wall of the bladder or when the instrument is laid on its side on the base and looks sideways towards one of the ureters Again, when some convex intravesical object—for instance a stone or a growth—is observed there is a considerable difference in the magnification to which its component parts are

* The rate at which magnification increases, however, is not strictly proportional to the rate of approximation , it exceeds the latter, so that at a distance of say ½ in when a magnification of 4 times would be expected, one slightly greater than this will be found (Newton's law)

subjected the most prominent area which is generally centrally placed in the field being enlarged to a much greater extent than the periphery (*Fig* 16)

Illumination—The degree of magnification could be increased indefinitely by increasing the power of the ocular As the magnification increases however it must be remembered that illumination decreases as the square of the radius of the exit pupil * Thus when amplified twice, the brilliancy of illumination diminishes to one quarter, and when amplified three times it is only one ninth (we are not taking into account the brightness of the lamp which has limitations, and may for present purposes be considered constant) Anyone accustomed to the use of optical apparatus prizes good conservation of light even more highly than magnification of the field It is evident, therefore, that just as with the objective a compromise had to be

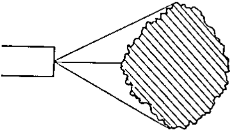


Fig 16—Diagram to indicate that the portions of a convex object closest to the prism are more highly magnified than those which are more remote

* The intensity of illumination is inversely proportional to the square of the distance from the source (*Fig* 17)

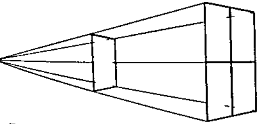
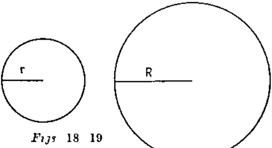


Fig 17—Illustrating loss of light by distance of lamp from object



Figs 18 19

If instead of a rectangle a circle (*Figs* 18 19) is used as a field—

If area (a) of circle of radius r $= \pi r$
and if area (A) of circle of radius R $= \pi R^2$
and if R $= 2$ r $\quad (R^2 = 4 r^2)$
$A = 4 \pi r \quad = 4a$

Therefore the intensity of illumination is inversely proportional to the square of the radius of the field

The same considerations apply to the illumination of the bladder wall by the lamp Thus a field ½ in away from the lamp will be 4 times more brightly illuminated than one 1 in away and 9 times better lit than a field 1½ in away It is obvious therefore that by approximating the beak of the cystoscope to the vesical wall there is a gain not only in magnification and definition owing to the optical properties of the telescope but also in illumination When however the object and the cystoscope are too close to each other the field of view and the area of brightest illumination may not correspond

effected between the extent of the field of view and its magnification, so with the ocular a compromise must be made between the degree of magnification and the illumination of the image Magnification may therefore be gained at the objective at the expense of a reduction in the extent of the field of vision, or it may be obtained at the ocular by the sacrifice of illumination In practice we get magnification and to spare, if we are able to approximate the objective of the instrument to the bladder wall

Good illumination, however, depends also on other factors We have reviewed the properties of the objective and of the ocular, and the considerations which govern their focal lengths The modern cystoscope has effected still more radical changes in the transporting lens system. We have seen that this plays a passive role as regards

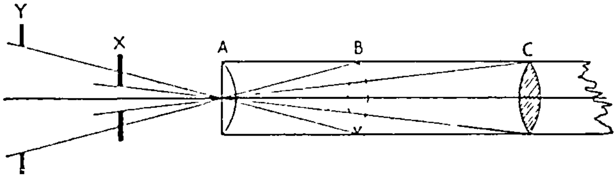


Fig 20 —Diagram illustrating the respective size of the entrance pupil in the new and the old lens systems

magnification, but we have now to learn that it is very important in regard to conservation of light In the original Nitze system a centrally placed convex lens served as a transporting system Multiple transporting lenses were first introduced by Lowenstein and Ringleb, and their work has subsequently been elaborated by numerous other investigators Though there are many variations in design, all cystoscopes now employ a number of lenses in this system

The amount of light passing through the central or inverting lens is measured in terms of the entrance pupil,* and the size of this

* Every lens system has an entrance pupil and an exit pupil, and on their respective sizes depend the essential qualities of an instrument When a cystoscope is held in such a position that the light from a distant source enters the ocular end, a very small circle of light of intense brightness can be observed at the bladder end This circle of light is called the 'entrance pupil' of the instrument If the position of the cystoscope is now reversed, so that the light from the distant source enters by the prism, a circle of light from 1 to 2 mm in diameter will be noticed if the instrument is about 25 cm from the observer's eye This is termed the 'exit pupil' of the instrument It is evident that the only rays of light that enter the lens system and the observer's eye are those that pass through the entrance pupil The size and position of the entrance pupil depend on the focal power of the objective, and the position and size of the inverting lenses By judicious selection and grouping of these inverting lenses appreciable improvements have been realized in the modern cystoscope Whilst the amount of light which enters the telescope is regulated by the size of the entrance pupil, the illumination or brightness of the final image is dependent on the size of the exit pupil An exit pupil equal in size to the pupil of the observer's eye is the most suitable, and as the latter is a variable factor, an average diameter of 2 mm has been adopted in most modern cystoscopes

entrance pupil increases as the distance between the objective and middle lenses diminishes

This is simply demonstrated in *Fig* 20 where C may be taken to represent the central lens as found in a Nitze cystoscope being far removed from the objective A The corresponding pupil is seen at X and is small in size and so admits little light B is the first lens of the transporting system in a modern telescope and Y demonstrates the large size of the corresponding entrance pupil thus allowing much improved illumination It will be observed that in Nitze's cystoscope all rays entering the objective and meeting the wall of the telescope between A and C are lost whilst in a modern instrument only those between A and B are lost *

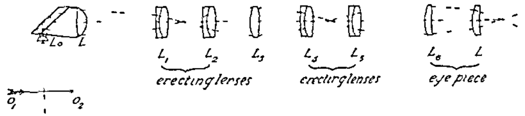


Fig 21 — Lens system used in instrument made by the Genito Urinary Manufacturing Co London O O The object I I Two parts of objective separated by a roof prism L I L L I Transporting system I L Eyepiece

Whilst approximation of the objective and the inverting lens has been effective in conserving light the distance between the latter and the ocular has now become too great The gap is bridged by a series of lenses and the whole group thus formed takes the place of the central lens of the Nitze cystoscope and is known as the transporting system in view of its function of transporting the image from the objective to the ocular The lenses vary in number and detail in different models A system is depicted in *Fig* 21 which represents a combination employed in one of the standard models made by the Genito Urinary Manufacturing Company of London The multiplication of lenses has made it possible materially to reduce the size of the telescope a fact which is of first class importance in the operating and catheterizing models as a small telescope makes additional room available for larger catheters and other instruments

Such are the principal qualities of the direct cystoscope and posterior urethroscope The limitations of this instrument soon

* In the diagram it may be remarked that the positions of the entrance pupil of the two systems are not the same which fact will appear at first sight to be unfair to the Nitze instrument They are however correctly represented for their location is determined by the position where the images of the respective lenses B and C would fall if projected through the lens A into the object space (conjugate foci)

become evident in practice, for it can only inspect those portions of the bladder wall directly opposite to the observer (fundus, etc, though indeed these particular areas are more conveniently brought into view by this instrument than by its successor, the indirect cystoscope) The summit and anterior wall, and large portions of the lateral wall, are hidden from view, whilst that most important area, the trigone, is greatly foreshortened and distorted (cf *Fig* 22).

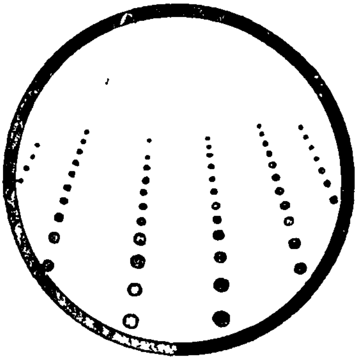


Fig 22 —Lines of parallel dots on a printed card seen through the cystoscope, showing the effects of foreshortening and distortion

For the above reasons Nitze early displaced the instrument by his indirect or prismatic cystoscope, an instrument in which to the three sets of lenses already described was added, at the vesical extremity, a right-angled prism capable of deflecting field rays entering its lateral surface through 90° into the telescope It is placed underneath an appropriately cut fenestra at the vesical end of the tube This ingenious modification marked a notable advance, for it brought into direct view the bladder base and the upper and other walls of the viscus which previously were unapproachable by direct cystoscopy

It nevertheless introduced a complication in that the picture reflected was a mirror view—that is to say, it is correct as regards

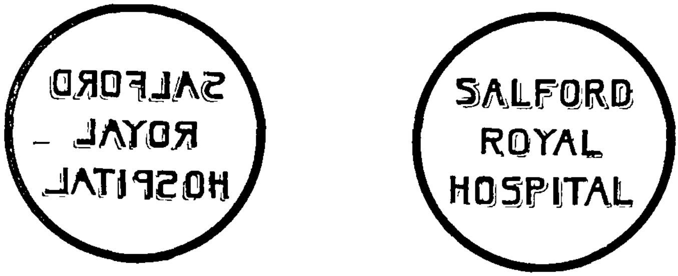


Fig 23 —Legend seen through uncorrected and corrected cystoscope

the upper and lower poles, but inverted as regards its sides (*Fig* 23) This single disadvantage of the indirect system was not remedied until 1906 when Weinberg introduced his 'Ortho-Kystoscope', which was improved upon in the following year by Franck, who placed a prism in the ocular end as shown in *Fig* 24, thus effecting a correction of the upper and lower poles

To-day all makers of cystoscopes obtain an upright or corrected image by some device or other, the Americans using an erecting

prism (central prism) near the ocular others producing correction at the bladder end The latter is the better method The prism shown in *Fig* 25 is used in instruments of British manufacture, and is known as the Amici or 'roof prism It was first employed in cystoscopic work by that able innovator Ringleb It consists of a right angled prism in which the hypotenuse is divided into two portions the planes of which cut each other at an angle of 90° like the roof of a house so that it really forms a double mirror and gives an image which is inverted not only in the direction of the upper and lower poles but also of the lateral poles so that by the provision of an odd number of inversions in the lens system a corrected image is obtained

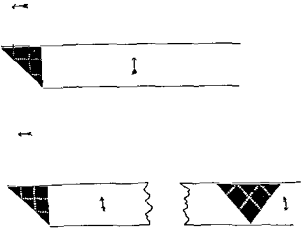


Fig 24 —Correction of image by insertion of an extra prism

The objective lens is made in two portions in order to avoid spherical and chromatic aberration sometimes one of these is placed on the vesical aspect of the prism, at others they are both placed in the telescope In models made by the firm of Wappler the prism together with the two lenses form a single unit cut as a hemispherical lens the plane surface of which being placed at an angle of 45° with the axis of the telescope reflects rays into that tube If tilted back through one or two degrees this lens can be made to give a retrograde view (*Fig* 26)

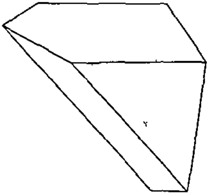


Fig 25 — Amici's roof prism

Each lens of the transporting system is also made of two portions the one consisting of flint and the other of crown glass When employed in correct proportions this combination obviates spherical and chromatic aberration

Recent Improvements by the Use of Non reflecting Films and Synthetic Cement *—When light from the illuminated bladder wall passes

* This paragraph is contributed by Mr R Schrinz of the Genito Urinary Mfg Co to whom the author gratefully acknowledges his indebtedness

through a cystoscope a small percentage, varying between 4 and 7 per cent * is reflected at each air-glass surface In a cystoscope consisting of 12 or more lenses the total loss of light due to reflexion may reach 45 to 50 per cent, in other words only about half of the incident light is transmitted and forms the image The reflected light is scattered and spread over the image like a thin veil, or it may focus in the image plane in irregular glare spots and form ghost images to the detriment of definition and contrast In the course of their research work on the interference of light Fresnel and Thomas Young studied these phenomena and discovered ways and means to counteract them Young demonstrated experimentally that reflexion could be eliminated by interference brought about by coating the glass surface with a thin film of transparent material (cassia oil) of a thickness equal to a quarter wave-length of the incident light and possessing a refractive index roughly midway between that of the two mediæ † It was however, not until many years later, about 1892, that Dennis Taylor discovered a method of producing durable films of this kind on glass with a high lead or barium content by a chemical process. As many optical components are made of crown and other silica glasses the Taylor process had only a limited application Within the last decade a new method has been discovered whereby magnesium fluoride or similar material can be deposited on any kind of glass by a high vacuum volatilization process. The loss of light by reflexion on a surface coated with a fluoride film of appropriate thickness is only about 1 per cent instead of an average of 5 per cent before coating When applied to all the lenses in a cystoscope the total loss for the whole system is reduced from 45–50 per cent to about 10 per cent, but owing to the logarithmic response of the eye to light stimuli ‡ the increase in brightness is not nearly so striking as the gain in definition and contrast due to the elimination of stray light

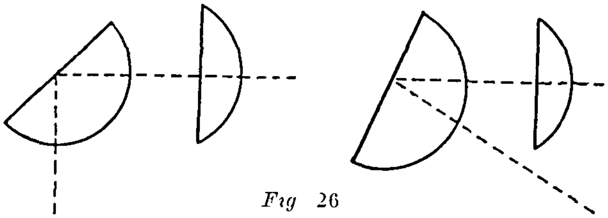


Fig 26

* According to Fresnel the fraction of light lost by reflexion on an air-glass surface is $\left(\frac{N-1}{N+1}\right)^2$ where N is the refractive index of the glass

† The refractive index of the non-reflecting film when the first medium is air must be equal to $\sqrt{Ng}$, Ng being the refractive index of the glass

‡ Logarithmic response of the eye—means that the sensation of brightness increases in logarithmic proportion to that of light In order that an object illuminated by a source of light of 10 candle-power appears twice as bright, the candle-power must be increased to $10^2 = 100$ candle-power

OTHER TYPES OF CYSTOSCOPE

The original Ringleb examining cystoscope has been taken as a pattern and described in detail Its catheterizing sheath is dealt with on *page 312* *Of other models* the Swift Joly and Buerger instruments are discussed and illustrated on pages 315 and 316 respectively There are many variations mostly slight of these primary patterns, but they scarcely need further particularization The most widely deviating are the pan endoscopes and the cysto urethroscopes , even with these *little difficulty should be experienced if those already* described are understood

Retrograde cystoscopes and/or their optical devices receive attention on pages 21 and 316 The lens system of the posterior urethroscope has been described in detail on pages 10-21

Of operating cystoscopes the Young rongeur (page 176) the *Kidd* fulgurating cystoscope (page 204) and Canny Ryall s cystoscopic lithotrite (page 227) are included The McCarthy resectoscope with its foroblique lens system is discussed on page 282 and the Bumpus punch on page 297

THE CARE AND STERILIZATION OF THE CYSTOSCOPE

The cystoscope is a delicate and valuable instrument and its owner will be well advised to give personal time and attention to its cleansing and sterilization or else to train with care the nurse who *is to be* responsible for *it* Lack *of proper attention will not only lead* to the deterioration of the instrument but will render it unsafe owing to inadequate sterilization

When the instrument has been used it must be taken to pieces for cleansing The compression screw (*see Fig* 5 C) which tightens the washer is *first of all loosened, and the optical portion can then be* removed The two screws which fix the leather washer and the valve respectively are next removed The instrument now consists of four

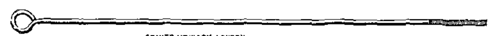


Fig —Wool holder for cleaning barrel of cystoscope

separate portions and each of these must be thoroughly cleansed by rinsing under running water and rubbing with a piece of lint particular attention being paid to flushing the interior of the barrel The two screws together with the valve and the faucet may now be sterilized by boiling or by dropping them into spirit * The remaining portions

* Boiling reduces the life of the washers attached to these screws but they are inexpensive and easily replaced they are moreover the only absorbent portion of the instrument and therefore most prone to retain sepsis

are incapable of standing treatment by heat as the cements which fix the lenses and prisms would be injured and the insulation of the wiring would be destroyed * Start, then, by removing all water with a clean towel, and next treat the exterior of each portion with a swab soaked in methylated spirit Now take the wool-holder provided for the purpose (*Fig* 27) and on to its roughened end wind closely a pledget of cotton-wool, soak it in methylated spirit, and with it cleanse the barrel of the catheter Then take the sheath of the instrument, and, placing a finger over the eye, fill it brimful of methylated spirit and allow it to remain thus for some seconds Those portions of the instrument which have been under sterilization by boiling may now be re-covered, and the cystoscope re-assembled Before fixing the valve see that it is working efficiently and is not being held open by any portion of debris or grit If the instrument is required for another case, it may now be put to stand in antiseptic lotion, the beaker in which it is contained being sufficiently deep to submerge the whole of the shaft Suitable lotions for this purpose are carbolic lotion 1–60, boric acid (sat sol), oxycyanide of mercury 1–1000, or methylated spirit The instrument should be allowed to stand in the selected lotion for fifteen minutes before being used again If it is not required for use immediately, each part must be thoroughly dried, special attention again being paid to the interior of the barrel and valve, and it should then be returned to its case

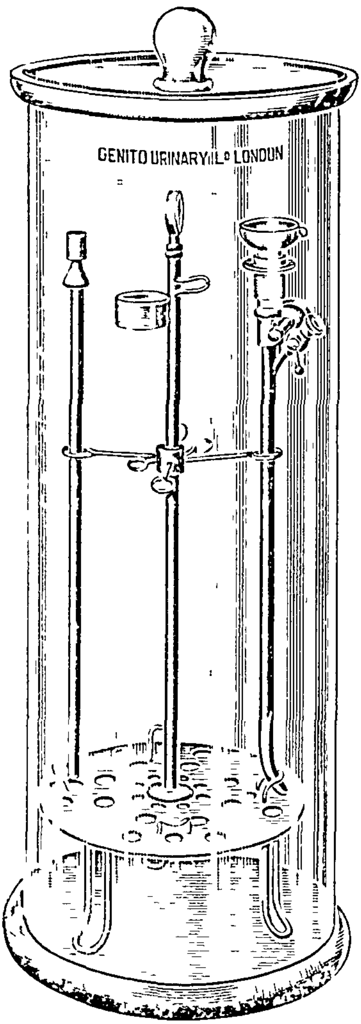


Fig 28 —Jar for sterilization of cystoscopes

If the surgeon is doing a series of cystoscopies he should attempt to arrange them in such order that the aseptic cases are dealt with first and the most septic last much in the same way as the cases are preferred on an operating list

Sterilization by Formalin.—Another method is sterilization by the vapour of formalin and this may be used either warm or cold

* See however, below (p 25)

If warm sterilization is obtained after half an hour but if the cold vapour is employed two days should be given to the process The method requires the possession of a number of cystoscopes if several examinations are to be conducted consecutively it also involves apparatus to sterilize them in For sterilization in the cold vapour an upright glass bottle or flask as shown in *Fig* 28 is used and the instrument is suspended therein There is a holder for the tablets of paraform which is generally situated at the upper part of the flask so that the heavy vapour will fall around the instruments Sterilization by warm vapour requires a special stove The vapour is freely liberated as soon as a temperature of 40° C is reached and if it is kept between this and 55° C no undue injury will be done to the instrument If however, the temperature rises above this point the instrument is liable to be damaged The stove is so constructed that a greater temperature cannot be attained A certain amount of deterioration eventually occurs in a cystoscope which is frequently exposed to warm formalin vapour and it is preferable when circumstances allow to obtain sterilization in the cold state

Before introducing any cystoscope into formalin vapour, care should be taken to see that it is perfectly dry, special attention being paid to such internal parts as the barrel valve, etc The telescope and catheter should be suspended separately and the instrument should be allowed to remain exposed to dry air for a time before being placed in the receiver A quantity of fresh calcium chloride should be sprinkled in the bottom of the jar to absorb atmospheric moisture During formalin sterilization the cords and switch of the instrument may be hung in the vapour and thus rendered aseptic

This method of sterilization is more efficient and penetrating than washing with antiseptics, asepsis being obtained in the numerous chinks and crannies which abound in the instrument many of which must escape adequate attention with the swab Its disadvantages are the length of time required and the consequent impossibility of using the same instrument on two cases consecutively In the irrigating cystoscope the bladder contents pass out through the barrel of the catheter which is subsequently used on a second case so that the possibilities of infection are obvious

Sterilization by Boiling—The difficult problem of producing a boilable cystoscope was solved in 1925 at the instigation of the late Sir John Thomson Walker The first instrument to be thus equipped was the Swift Joly Now all cystoscopes made by the Genito Urinary Manufacturing Co have catheters which are boilable The standard telescope must not be boiled but boilable ones will be supplied if specially ordered Neither the sheath nor telescope will stand prolonged immersion such as is employed for ordinary surgical instruments

The separated components should be put into tepid water and brought slowly to the boil. After half a minute on the boil the tray in which they rest is removed from the sterilizer and they are allowed to cool. They will suffer injury if seized with ordinary instrument forceps. Cystoscopes must not be placed in the sterilizer together with other instruments unless enclosed in a special compartment. Sterilizing boxes with perforated walls are provided for this purpose. Hard water must be avoided, as it deposits a chalky precipitate on the moving parts and they become clogged. If the town's supply is hard distilled water should be employed. The advantages of sterilization by heat are self-evident, particularly in an instrument which has so many chinks in which to secrete sepsis.

The recent discovery of a synthetic cement unaffected by heat in excess of 100° C. has notably improved the quality of boilable cystoscopes. The lens systems of these instruments have up to now been a little inferior to those of non-boilable cystoscopes because the achromatic objectives could not be cemented; Canada balsam, the only material available until recently disintegrated before boiling-point was reached. On the other hand the use of uncemented objectives has the disadvantage of increasing the number of reflecting air-glass surfaces in the system with a corresponding additional loss in brightness and contrast (*see* page 22). Synthetic cement and non-reflecting films have now eliminated these defects; the boilable cystoscope of the future will equal in performance the non-boilable type.*

THE EXAMINATION OF THE CYSTOSCOPE BEFORE USE: TRACING FAULTS

Some time before it is required an examination of the cystoscope should be made to ascertain that all its various parts are functioning perfectly. Faults may occur at many points and will be considered under three headings: (1) *The lighting*; (2) *The valve*; (3) *The telescope*. A knowledge of the causation and methods of locating faults will often obviate a return of the instrument to the makers.

1. The Lighting.—All breakdowns of the lighting system result in the failure of the lamplight, and when this occurs it may be due to a fault in any part of the circuit, and the site of the breakdown must be located by a process of exclusion. The possibilities may be conveniently considered under the following headings: (*a*) Lamp; (*b*) Internal wiring of the cystoscope; (*c*) Battery and cords; (*d*) Switch.

When working with a combination set an alternate sheath is supplied so that the one which has failed can be replaced by its

* For the information contained in this paragraph I am indebted to Mr R. Schranz, of the Genito-Urinary Mfg Co.

neighbour (it is presumed unlikely that both cystoscopes are simultaneously at fault) If this second instrument lights it will exclude any fault in the battery or the cords and switch and will point to the apparatus distal to these as the site of the trouble—namely, the sheath or the lamp Conversely if it fails suspicion will be thrown on the battery cells cords and switch

a Lamp—Taking the former case first, one will naturally examine the two parts (sheath and lamp) separately Unscrew the lamp and examine the central protruding filament Elevate it with a pin and test the lamp across the switch as shown in *Fig 29* A lamp which is fused generally gives rise to suspicion by discoloration of the bulb A break in the wiring may sometimes be seen on close inspection Should the lamp prove faulty it is put on one side for refilling and is replaced by a fresh one from stock The lamp is the element which most commonly breaks down but it is also the one which is most easily remedied Before replacing the lamp make a habit of removing any foreign substance grease or dirt from the copper terminal at the bottom of the lamp socket in the end of the cystoscope by scraping it with a pin Make sure that the filament is projecting well before returning the bulb to its seating Exceptionally a terminal which is actually too long has given trouble by coming into contact with the sheath and so forming a short circuit

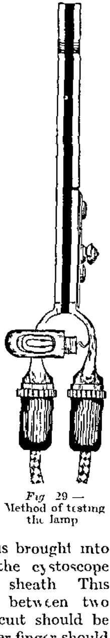


Fig 29 —Method of testing the lamp

b Internal Wiring of the Cystoscope —Should the lamp battery, and external wiring have been proved efficient the fault is traced to the internal wiring of the cystoscope Glance at the connecting rings which unite the cystoscope to the switch and reassure yourself that these are clean A short circuit in the instrument itself can be confirmed in the following way —

Remove the lamp from its fitting Place the body of the cystoscope in circuit with one pole of a voltmeter the other pole of which is in contact with a battery terminal The other battery terminal is brought into relationship with that electric connection ring of the cystoscope which is fused to the wire lying in the floor of the sheath This ring may be identified by the fact that it rests between two insulating rings In the absence of the lamp no circuit should be formed when the current is turned on and the voltmeter finger should

remain at rest In the presence, however, of a defect in the insulation a current will be registered on the voltmeter

c. Battery and Cords—If the defect proves to be in the proximal (battery and cords) section of the circuit these must be alternately replaced in order to find out which is wrong. The wires of the instrument not infrequently form faulty contact with the switch or other terminals, and it is little wonder, for they are repeatedly subjected to improper handling with the result that the copper breaks within its coverings, the site of election being the point where it joins the switch or ebonite plugs At these sections the coverings are reinforced, but they nevertheless remain vulnerable points Two rules may be laid down (i) When coupling up to the battery box grasp the body of the ebonite plug particularly avoiding pressure at the end where the wire emerges, as this kinks and breaks the metal wire; (ii) Similarly in disconnecting at either end pull on the terminals themselves and not on the wires

Faults in these external wires are characterized by intermittency of the light By pushing the wire towards its seating, or by withdrawing it the circuit may be made or broken If at one point the coverings are seen to be frail the break in the wire will probably coincide

d Switch.—The switch is a fairly frequent offender; it may give rise to trouble in two ways (i) The slide is by far the more common transgressor Adequate contact with the distal portion of the split plate is regulated by the correct tightness of the two screws which fix it When too tightly or too loosely screwed home the slide fails to connect the two portions of the divided plate Pressure by the thumb immediately re-establishes continuity, and this can quickly be made permanent by resetting the screws with a screwdriver (ii) It was customary at one time to unite the two opposing plates of the switch by means of insulated metal screws It occasionally happened that the seating of one of these screws became disturbed or perished, with the result that a short-circuit was produced In modern instruments ebonite or bakelite pegs have replaced the metal screw and this cause of trouble has therefore disappeared at least so far as recently made instruments are concerned.

2. The Valve.—Examine the valve before inserting it into the valve chamber for it is often found to be out of order through some trifling portion of grit or other foreign substance holding open the clapper The hinges may become stiff so that the spring is incapable of closing the valve whilst the soldering of one or other of the wires not uncommonly gives way

When the valve is faulty fluids escape from the bladder until the telescope is inserted A finger may be placed over the outlet to counteract this Some surgeons consider that the frequency with

which the valve goes out of order renders its use inexpedient and have discontinued to employ one, closing the outlet with a finger. The finger, however, is very liable to be contaminated by touching objects the sterility of which cannot be guaranteed, and its close contact with the vesical contents is therefore undesirable.

3. **The Telescope.**—In examining this part of the instrument take it in one hand and hold it so that the prism faces a lighted window or an electric light, and, placing the eye to the ocular, note (*a*) The clarity. (*b*) The outline and extent of the field.

a. Clarity.—If not clear, the cause will probably be found in a badly cleaned ocular or objective. Start by cleaning the ocular, using lint or gauze. Greasy substances on the lenses are conveniently removed by methylated spirit. Having cleaned the ocular, pay attention to the window of the prism. In doing this be careful to support the vesical end of the telescope whilst rubbing in order to avoid torsion or bending of the long and malleable shaft. Spots or other opacities remaining after cleaning of these external parts are situated in the interior of the telescope and must be remedied by the makers.

Fig. 30.—Ellipse of field of view cut off owing to bend in the telescope.

b. Outline and Extent of the Field.—It has already been indicated that the manufacturers of cystoscopes are severely restricted in the calibre of the instruments and that the thickness of the tubing of all parts is reduced to a minimum. Such attenuation involves greater delicacy and malleability. Bending of the telescope is therefore a frequent accident. Very slight distortion will be quite sufficient to cut off a large portion of the field in so long and narrow an optical system. The appearance seen in *Fig.* 30 results from a slightly deflected telescope. The dimly illuminated crescent owes its existence to rays of light reflected from the lateral wall of the tube.

A slightly damaged telescope can be used temporarily, as a portion of the field still remains. Moreover, when it is introduced into the sheath the rigid walls of the latter partially restore its shape. It is possible to straighten the telescope with a little gentle pressure, but it is wiser to return the damaged part to the instrument maker. A telescope is often bent through forgetting to unscrew the compression screw of the cystoscope before inserting it into the sheath.

If the mains are *alternating*, a small earth-free static transformer can be used. A convenient model is shown in *Fig* 33. With this the low voltage current is generated in the secondary winding entirely by induction and has no electric connection with the town's mains. Such an arrangement is quite satisfactory.

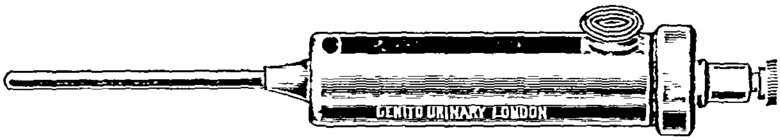


Fig 32.—Sliding rheostat for direct connection to the terminals of dry cell

If the supply mains are *continuous*, the problem is not so simple, and the best plan is to convert in the first place to alternating and then employ a suitable static transformer. To do this some form of motor or rotary converter must be employed, and the so-called 'Universal Machines' embody a suitable motor and also usually an

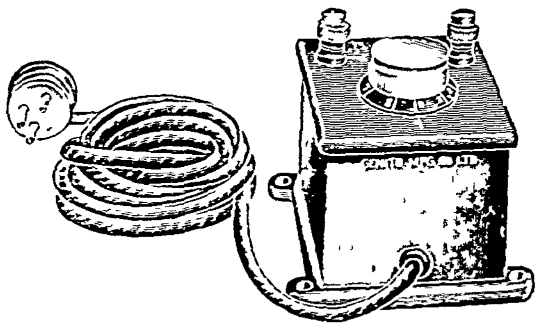


Fig 33.—Transformer for alternating current

earth-free transformer. The exact arrangement may vary with different machines but the main point—namely that there must be no direct connection to the supply mains—should be regarded as fundamental.

3. An Accumulator.—Use may be made of an accumulator, but it is not very suitable. Its large size and weight are inconvenient, especially for travelling. It is expensive in the primary outlay and also in upkeep. It will give a light continuously for many hours, but should be recharged periodically, even when not in use, as it tends to discharge spontaneously. It deteriorates when not fully charged.

CHAPTER III

EXAMINATION OF A UROLOGICAL PATIENT

ORDER OF INVESTIGATION

During the present century the invention of new instruments and the discovery of fresh means of diagnosis have greatly increased both the complexity of our investigations and the length of time which must be devoted to them. Within living memory our predecessors were able to complete the examination of a case by methods which were clinical in the narrow sense of the word, and in a short period of time could send the patient away fully diagnosed according to their lights. Under modern conditions a complete overhauling is often spread out over a number of days, and is a research in which many men collaborate.

In no department is this more true than in urology. A patient who presents himself to-day at a urinary clinic must give up several days to being investigated. The surgeon who undertakes the work should have in his mind a clear conception of the order and progress of the inquiries to be pursued. If they are made in a haphazard way time will be lost, efficiency sacrificed, and the patient may become dissatisfied by the extent of his examination. The schema on page 34 sets out the principal investigations required in an average urinary case together with their order and spacing. It shows the routine adopted in my own hospital clinic, and can be recommended as a basis from which other schemes may be evolved to fit the special requirements of other hospitals. A glance at it will show that the investigation is so arranged as to occupy three visits to the Out-patients Department, and the object of each visit is indicated.

First Visit to the Out-patients' Department.—Once a week an out-patients session is taken to which fresh cases are referred and at which old cases and late operation cases can also be seen. The new cases are those which interest us at present, and at this, their first visit to the hospital, a record of the history and symptoms is obtained, and a couch examination for physical signs is made. The urine is tested by the usual clinical methods, and an intelligently collected specimen is sent for laboratory investigation. The specimen tested at this first visit is *not* a catheter specimen; this will be obtained later on the third occasion that the patient comes to the hospital (page 50). It

Schema for the Examination of a Urological Patient

First Visit to Out-patients' Department (*See also the Appendix*)

Clinical—

1 History

2 Symptoms
- Pain and other sensory disturbances
- Alterations in the act of micturition, especially frequency, strangury, and obstruction
- Alterations in the urine observed by the patient, especially hæmaturia

3 Signs and physical examination —
- Inspection
- Palpation
  - Renal, Vesical, Genital — and general abdominal
  - Rectal or vaginal
- Percussion

General conditions (uræmic, cardiac, respiratory, central nervous system, etc)

Urine—

Clinical tests —Naked-eye appearance, reaction, specific gravity, albumin, blood, pus, sugar, etc

Laboratory tests
- Chemical
- Histological
- Bacteriological

Second Visit to O P

X-ray Examination, including excretion urography

Third Visit to O P

Cystoscope—
- Exploratory
- Chromocystoscopy
- Bacteriology of catheter specimen of urine

Wards *

Cystoscope—

Catheterizing —
- Histological examination, Functional examination — Separated urines
- Pyelogram
- Treatment

Function—
- Total renal function
- Separate ,, , —ureteric catheter and separation of urines

* This work is now carried out in the clinic at the third visit to the Out-patients' Department, an arrangement which has been rendered necessary by the large amount of clinical material to be dealt with The installation of a small X-ray set in the Genito-urinary Department renders pyelography possible and is quite indispensable Only when patients are feeble, or would have a long train journey, are they now admitted to the wards for these examinations

is collected however with a view to the exclusion of urethral pus For this purpose the patient is instructed to urinate into two separate receivers The first urine sweeps before it all the urethral contents,

and the second may be regarded as representative of the urine as it occurs in the bladder. Any difference between the two specimens is noted and must be regarded as indicative of the condition of the urethra; the diagnosis will be affected thereby, as also will the advisability of cystoscopy (see also Appendix).

This two-glass method of testing is very frequently used in the male, where urination into two specimen glasses will aid the inspection of the fluid for opacities, etc. It is most important in the exclusion of urethral disease. In the female it is less often used, but is nevertheless possible and desirable. The first glass in this sex, even in health, invariably contains a considerable quantity of opacity, chiefly mucus and epithelium derived both from the urinary and genital passages, whilst the second glass in health is clear. The naked-eye inspection of the urine in the female is just as important as it is in the male, and with a little care the specimen can be acquired. It is desirable to know, even at this early stage of the investigation, the contents of the bladder urine free from urethral contamination. It is, however, objectionable to employ a catheter at the present juncture, especially in view of the fact that the bladder probably holds some unknown morbid change itself, rendering catheterization inexpedient. The second specimen, gathered as above, may be regarded as representative of the bladder urine, but its condition will be corroborated subsequently at the third visit to the hospital, when an actual catheter specimen will be obtained.

Second Visit to the Out-patients.—The next step is an X-ray examination, and as two days must elapse before the alimentary canal can be rendered fit for this, the patient is provided with a card on which are printed directions how to prepare for a radiological examination. The card will vary according to the premedication adopted at different hospitals. In my case it gives instructions concerning a purgative (preferably castor oil) to be taken on each of two nights previous to the examination; this purgative must contain no metallic drugs. Also, in the event of the patient's being inclined to constipation or being stout, it advises the administration of an enema on the morning of the visit. Only a light diet is to be taken on the actual day. It is a good thing also to avoid cellulose in the diet for a couple of days prior to the examination, and charcoal biscuits may be recommended if the patient is inclined to flatulence.

Third Visit to the Out-patients'.—The surgeon sets aside a portion of another day for the cystoscopic examination of his patients, and this may conveniently fall two or three days after the X-ray examinations have been completed, so that films and radiologists' reports may be available for personal inspection. A limited number of cystoscopies should be arranged. Care should be taken that

adequate time can be given to each case, as nothing is more productive of bad results than hurry The number will be determined by the amount of time which is set apart, the assistance available, and also by the accommodation provided in the Cystoscope Department

When the surgeon arrives he should find collected on his desk notes of the histories, symptoms, and signs which were obtained a few days previously, together with the reports on the urines from the laboratory and the X-ray films and their reports These are read through carefully and considered, after which the surgeon is in a position either to proceed to the cystoscopy in the out-patients' department or to arrange for the admission of the patient for this purpose, as he may judge best

CYSTOSCOPE DEPARTMENT

A department devoted exclusively to urological work is essential in any hospital where a considerable quantity of this material is handled The lay-out which I devised for the Salford Royal Hospital (*Fig* 34) proved eminently satisfactory It will be seen that there are three cystoscope rooms, each with its dressing-room The latter contains a couch which is useful for recumbency, if required, subsequent to cystoscopy and is valuable during out-patient sessions (non-cystoscopic) for abdominal and other examinations, and at stricture clinics

The provision of a waiting-room for patients, a surgeon's consulting-room and a sterilizing-room will be noted An X-ray plant is available in two of the three cystoscopic rooms and is an indispensable item of the equipment It relieves the general radiological department of the congestion caused by numerous excretion urograms and obviates the movement of patients with ureteric catheters in position which is objectionable on several grounds A small dark-room for film development is provided

In hospitals where such a department is not available the operating theatre is called into commission for cystoscopies If more than one or two cystoscopies are to be carried out the lack of sufficient rooms causes much delay and the need of X-ray equipment to hand is also keenly felt

INDICATIONS FOR AND CONTRA-INDICATIONS TO CYSTOSCOPY

In the absence of contra-indications most urological patients will be cystoscoped In many this will prove to be the most valuable diagnostic agency employed, in few will it be superfluous Even where the diagnosis is apparently straightforward—for instance, a renal stone which is shown in the radiograph—much accessory

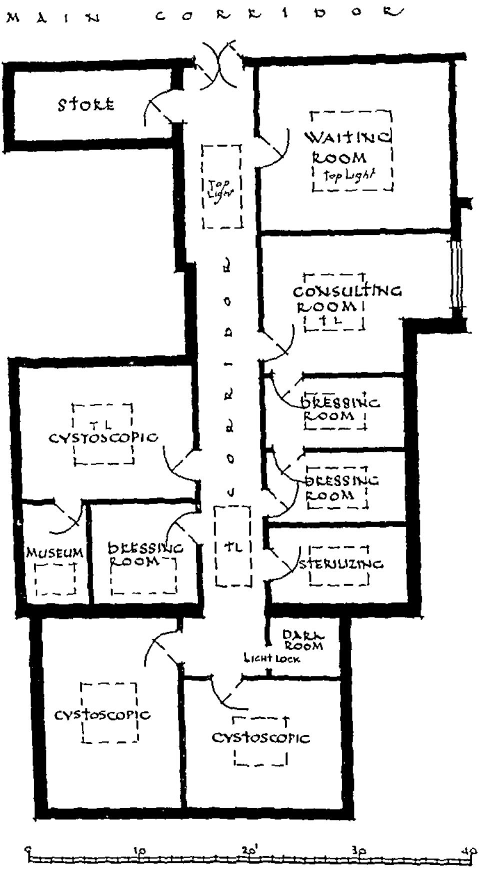


Fig. 34.—Plan of cystoscopic clinic

information may be acquired by the cystoscope This will chiefly concern the presence and function of the second kidney, but often unsuspected complications are found which throw light on the case and alter the attitude of the surgeon to treatment

It is undesirable to attempt cystoscopy in any acute infection of the lower urinary tract Acute anterior or posterior urethritis would be injuriously affected by instrumentation, as would also acute prostatitis The examination would be painful and it would involve the risk of infecting the bladder Acute cystitis is not an absolute contra-indication, but it is generally better to avoid cystoscopy until a less acute stage is reached, unless there is some pressing reason for its performance

ANÆSTHESIA

There are four methods of inducing anæsthesia for cystoscopy. They are · (I) *Local*, (II) *Sacral*, (III) *General*, (IV) *Spinal* The best of all anæsthetics, however, is a gentle and educated touch, and no other kind will make up for a lack of this Local anæsthesia is specially applicable to routine out-patient work The patient is usually admitted to the wards for spinal and general anæsthesia, though a low spinal is quite often used in the out-patients' and also general anæsthesia The latter is the most suitable for children.

I LOCAL ANÆSTHESIA

A clear idea of the possibilities and limitations of local anæsthesia is requisite. The problems that need to be considered are (1) *The urethra* (*a*) *in the female*, (*b*) *in the male*, (2) *The bladder*

1. The Urethra.—

a In the Female—The urethra is short, straight, and mobile, has only one sphincter, and no specially sensitive areas The amount of urethral pain caused by introducing the cystoscope is negligible, and it is momentary, for as soon as the instrument is in place it ceases As a rule I use no local anæsthetic; but if for any reason one is considered desirable, the application of a crystal of cocaine to the external meatus the most sensitive spot, can be recommended A convenient method is to place one or more lamellæ of cocaine just within the external meatus and leave them there for a few minutes to dissolve when the investigation may be proceeded with

b In the Male—The urethra is a long curved channel, divided into two sections an anterior and a posterior: it has two sphincters, is fixed by membranous ligaments at its proximal end, and contains two hypersensitive areas—the position of the compressor urethræ and the verumontanum From the point of view of local anæsthesia it presents three problems (1) To anæsthetize the anterior urethra

(ii) To anæsthetize the posterior urethra (iii) To allay the pain caused by straightening out the more or less fixed curves of the proximal urethra

The anterior urethra is treated by the introduction of a solution of one of the substitutes for cocaine Novocain (5 per cent) nupercain (0 1 to 0 15 per cent) and stovaine (4 per cent) can be recommended Novocain being non penetrating is known to be a poor anæsthetic for mucous surfaces but has nevertheless considerable

Fig 35—Everidge's urethral syringe

popularity Nupercaine is somewhat toxic, but as it is ten times more powerful than cocaine and novocain this toxicity is nullified Alypin (di methyl amino stovaine) is popular in America It is supplied in tablets of which 2 to 4 can be placed in the anterior urethra and 2 can be later passed into the posterior urethra by means of an applicator The addition of adrenaline (20 minims of a 1–10 000 solution to every 100 c c of anæsthetic solution) to any of these drugs diminishes absorption and concentrates their action

Any form of urethral syringe (*Fig* 35) may be employed to introduce anæsthetics which are in solution The urethra should be fully distended, and then a clip (*Fig* 36) should be placed on the

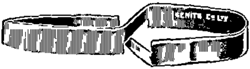


Fig 36—Thomson Walker's penile clamp

tip of the penis in order to retain the fluid for a few minutes At the end of this time the surgeon takes hold of the end of the penis with the left hand and with the right hand in the perineum massages the fluid back past the anæsthetized compressor urethræ into the posterior urethra Here it is allowed to remain for another similar period when the whole length of the urethral mucosa will have been exposed to the action of the drug

Methods of anæsthetizing the posterior urethra which involve the introduction of an Ultzmann syringe or an applicator for dropping pellets are nearly as painful as the *introduction* of the cystoscope itself and therefore not to be recommended

Though the discomfort which is caused by straight*ening out the* curves of the posterior urethra cannot be relieved by local anæsthesia

one precaution may be taken to reduce it. When the thighs are flexed slightly on the trunk the suspensory ligament of the penis is relaxed, whilst if they are extended it is on tension. Whatever position is chosen for the cystoscopy the operator should see that the thighs are slightly flexed so as to avoid unnecessary strain on this portion of the passage when the penis is depressed by the instrument (*see Fig.* 42).

If a series of patients is to be examined an assistant should be deputed to induce local anæsthesia in an ante-room; by this means considerable time is saved to the surgeon.

2. The Bladder.—The tactile and pain sense of the healthy bladder *mucous membrane* is of a very low order. A ureteric catheter may touch it without being perceived by the patient, and even a stilette may be placed against it without eliciting pain. A patient who has passed a stone from his ureter into his bladder—the latter being healthy—is barely conscious of its presence until either he commences to pass it out per urethram or the bladder becomes inflamed and therefore sensitive. If the tactile sense were not thus low, the presence of even a small quantity of urine in the viscus would undesirably obtrude itself upon the consciousness. Langley and Anderson have shown that in the hypogastric nerves afferent fibres are present in proportion to efferent fibres only as 1 : 10, and Langley has suggested that the paucity of afferent nerve-fibres is the reason for the high threshold to sensory stimuli.

With the inflamed bladder, however, it is different. The organ becomes sensitive as soon as it is inflamed. Guyon demonstrated that a stone is not felt in a healthy viscus, but that when it has given rise to an area of inflammatory reaction at the position where it rests pain is experienced. Whenever the bladder is inflamed, even superficially, some lowering of the threshold for sensory stimuli will be found. This lowering advances in proportion to the depth to which the inflammatory process has penetrated rather than to its superficial extent. When the deeper coats of the bladder are involved, vesical tenesmus makes its appearance. A single area of ulceration gives rise to more irritation than a widely diffused but superficial cystitis, as may be realized by comparing the tuberculous bladder with that of simple cystitis. This variation in the tolerance of different organs led the old school of urologists to classify cystitis according as it was painful or painless. The point from which these more painful stimuli arise appears to be deep, probably in the *muscular* coat.

Local anæsthesia, though capable of controlling pain arising in the mucosa of the bladder, is useless for that originating in the muscle or indeed for the pain caused by the distortion of the deep urethra in the male. These are the two most important causes of discomfort

in cystoscopy They are completely controlled by spinal, and in rather uncertain degree by sacral, anæsthesia

II SACRAL ANÆSTHESIA

The bladder has a dual innervation through the sacral plexus and through the sympathetic the former being the more important Each of these carries afferent and efferent fibres and is in part responsible for the sensory and motor supply of the bladder The sacral nerves in addition innervate the prostate and urethra The sympathetic fibres gain access to the central nervous system via the lower thoracic

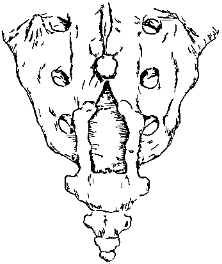


Fig 37 —Lower part of sacrum showing bony landmarks around the hiatus

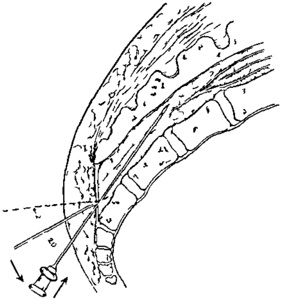


Fig 38 —Introduction of needle for sacral anæsthesia Note lower limit of membranes which however is variable

and upper lumbar roots Head has shown that they carry stimuli caused by over distension or prolonged distension of the viscus Caudal injection is capable of blocking impulses travelling via the sacral nerves and therefore anæsthetizes the urethra prostate and in part also the bladder An area of skin and the rectum and anus are included It leaves unaffected the sympathetic distribution to the bladder which however is a relatively unimportant channel

Technique —The patient's buttocks are exposed and he lies face downwards on a couch The skin overlying the sacrum is sterilized with iodine A needle 2½ in long attached to a large Record syringe filled with solution is employed The position of the sacral hiatus is identified by palpation two tubercles which guard its entry forming useful landmarks (Fig 37) Its aperture is closed by an obliquely placed fibrous membrane whose resistance is recognizable

as the needle perforates it The point is made to pass through this membrane perpendicularly, but immediately afterwards the needle is depressed so as to bring it into line with the sacral canal (*Fig* 38) It is gently guided along this channel for a distance of about $1\frac{1}{2}$ to $2\frac{1}{2}$ in Occasionally it hitches on irregularities on the bony boundaries, from which, however, it is easily freed by a little manipulation, and eventually it is held up by the natural curve of the canal. Abnormalities, however, are not infrequently so marked as to render the passage impossible When the needle is in position the surgeon pauses momentarily to assure himself that neither blood nor cerebro-spinal fluid escapes This is a rare accident, but should it happen the needle must be withdrawn a suitable distance The dura mater extends to the level of the second or third piece

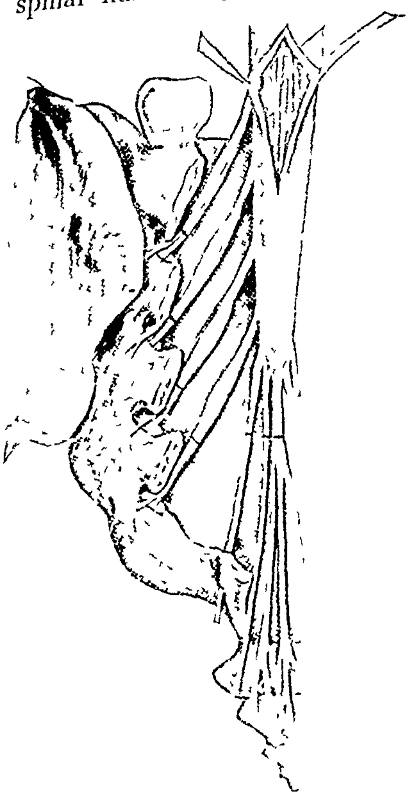


Fig 39 —Dissection to show arrangements of nerve elements in sacral canal Transverse lines on nerves show approximate limit of investing membranes The nerves are invested with membranes to a point just distal to their ganglia, and the membranes are impervious to anæsthetic solutions The lumbar and upper sacral ganglia occupy the intervertebral foramina The lower sacral and the coccygeal nerves, on the other hand, have a longer post-ganglionic course within the sacral canal, and it is apparently here that they are most easily affected by injected solutions This accounts for the mode of onset and the ultimate development of anæsthesia It is found clinically that the 5th sacral segment (anus) is always the first and most completely anæsthetized and that the 4th (region anterior and lateral to the anus) follows The 2nd and 3rd sacral segments (scrotum and penis in the male, vulva and clitoris in the female) are affected later and less deeply The extent varies with the quantity of fluid used

of the sacrum and the injection must be extra- or epi-dural, and the extent to which the roots are invested is shown in *Fig* 39 The needle should not encounter resistance, for that would indicate that its point is buried in periosteum If necessary it can be liberated by withdrawing it slightly The anæsthetic should be introduced slowly and its injection should be painless

Solutions Employed.—A solution of novocain is made to the following formula —

℞	Novocain	0 60 g
	Sod bicarb	0 15 g
	Sod chlorid	0 10 g

Dissolve in 30 c c of distilled and sterile water The whole 30 c c to be injected Different workers use different quantities of fluid for injection into the sacral canal, but many emphasize the necessity for a sufficiency

The novocain is kept in powders ready for use and is added to boiling water just before it is required It is boiled for two or three seconds only Boiling for more than this converts the sodium bicarbonate into an alkaline carbonate which is a powerful irritant The bicarbonate deepens and prolongs the anæsthesia

Results—The onset of anæsthesia occurs in four or five minutes, and reaches its fullest development in fifteen to twenty minutes The patient remains face downwards during the first ten minutes in order that such fluid as escapes from the sacral canal may pass forward along the course of the emerging nerve roots and be absorbed by them At the end of this time he may move to the cystoscopic chair for bladder preparation Occasionally there is some unsteadiness of gait

Sacral anæsthesia was previously much used in my department but has been given up Its results are good but not uniform, there are too many failures Many patients experience considerable pain at the site of the injection which may last for a day or two

III GENERAL ANÆSTHESIA

General anæsthesia is frequently employed for in-patients being examined in the operating theatre It is useful for children and nervous or unreasonable subjects, and for prolonged cystoscopic operations It temporarily depresses kidney function owing to its toxic effect on the renal epithelium and to its lowering the blood pressure It must therefore be employed with discretion when function tests are being made Its effect in this direction has, however, been exaggerated

IV SPINAL ANÆSTHESIA

Spinal anæsthesia gives the most profound degree of insensitiveness available and has been greatly used by the writer It is much appreciated by patients The low level obtainable by the modern technique is all that is required and if this is kept to the lowering of the blood pressure is slight and interferes but little with renal function tests The anæsthesia is so deep that the cystoscopist should be particularly careful not to overdistend a diseased bladder

PREPARATION OF THE BLADDER

Premedication and Preliminary Treatment—For a day or two before and after cystoscopy it is a good plan to administer antiseptics by the mouth and the following prescriptions may be recommended —

1 When the urine is strongly acid Hexamine 10 gr three times a day before meals

2 When the urine is neutral or alkaline The hexamine may be given as above recommended and a mixture containing acid sodium phosphate, 10 to 20 gr (alternatively ammonium chloride or nitrate) and tincture of hyoscyamus, 15 to 30 min, administered after meals, the *p*H of the urine being kept below 5 6

The hexamine is given before meals in order to avoid, as far as possible, excess of free hydrochloric acid in the stomach Since the introduction of the sulphonamides and other new drugs hexamine has undeservedly lost popularity The toxicity of the former class diminishes its general applicability For purposes such as the present one hexamine is the most useful and easily taken drug

Certain conditions must be fulfilled before cystoscopy can be performed The urethra must be capable of admitting a cystoscope. The bladder must be of sufficient size and the contained medium clear enough to allow a view of the wall to be obtained The very large majority of cases present no insuperable difficulties in these respects and therefore it is wise to make the first exploration of the urethra and bladder when preparing for the cystoscopy Should difficulties then be encountered, little or nothing will have been lost. Some operators however, especially on the Continent make a habit of testing the urethra and bladder instrumentally a few days before the cystoscopy is undertaken For this purpose they pass a catheter of about 23 French gauge to prove the urethral permeability and then, having withdrawn the urine from the bladder, they inject fluid to estimate the vesical capacity Such a procedure is unnecessary and meddlesome It is open to grave objection in that the bacterial content of the urethra is unknown, whilst the bladder may be pathologically susceptible to infection If sepsis is introduced, for instance, into a tuberculous bladder or one containing a neoplasm, not only may the cystoscopic picture be changed but also the whole course of the disease may be altered for the worse If, however the history of the case definitely suggests a stricture, it may be considered desirable to investigate its size by bougies prior to the cystoscopy It should be remembered however that the point of a bougie particularly a metal bougie is liable to bruise the roof of the bladder as I have demonstrated on many occasions especially if the bladder is not full at the time it is passed The small submucous hæmatoma which results is liable to confuse the diagnosis and is not a desirable addition to a bladder the pathology of which is as yet unknown

The capacity of the bladder should never under any circumstances be estimated by distending it Reduction in size or irritability can usually be surmised from a history of frequent or urgent

micturition, whilst lack of clearness of the medium may be anticipated as a cause of difficulty when the second of two urines passed into separate glasses is seen to be purulent If large quantities of pus are present in this second glass, it may prove impossible to get the bladder sufficiently clear for examination It should nevertheless, be left to the time of the cystoscopy to see whether or not this is so for it is only exceptionally that cystoscopy fails from this cause in experienced hands

In the interval preceding the operation oral administration of urinary antiseptics may be tried but has probably already been

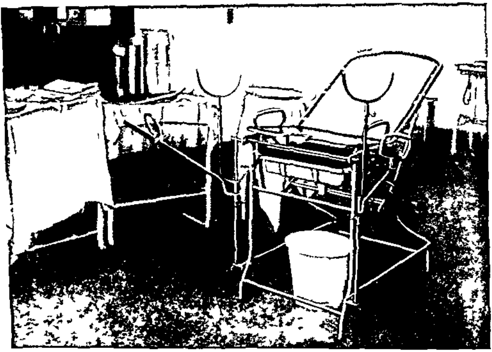


Fig 40 — Cystoscopic chair

employed Vesical lavage should be avoided In some cases it would doubtless be valuable in others it would certainly be harmful and it is not easy to forecast the reaction beforehand Its value or harmfulness depends on the presence or absence of an underlying cause for the cystitis To diagnose the underlying cause is one of the objects of the examination and an opinion regarding its presence prior to the cystoscopy must be mere surmise If the cystoscopy fails it is then time enough to resort to bladder washing

Position of the Patient —If the best results are to be obtained it is expedient that cystoscopy should be conducted by the surgeon in comfort and for this purpose the axis of the instrument must correspond approximately to the horizontal when the bladder base is

being inspected When the patient is correctly placed the base of the bladder, as it is traced posteriorly, recedes gently from the horizontally held cystoscope (*see Fig* 52 page 58) and is easily inspected The position of the vesical floor is regulated by that of the bony pelvis as the bladder is fixed thereto It will be found that, when the sacrum is resting flat on a cystoscopic chair (*Fig* 42) conditions are favourable for an easy examination The patient is put on the chair (*Fig* 40) with the buttocks reaching to the edge of the seat and the back of the chair is slightly raised The knees are supported on the rests, and the feet occupy the stirrups* (*Fig.* 41) The thighs should make an angle of about 45° with the trunk (*Fig* 42), for in this position they avoid tilting the pelvis and thus altering the lie of the vesical base Variations from the

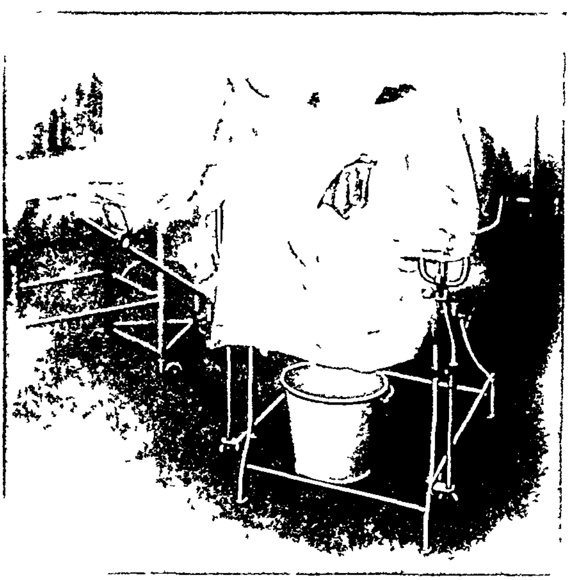


Fig 41 —Patient in position for operation

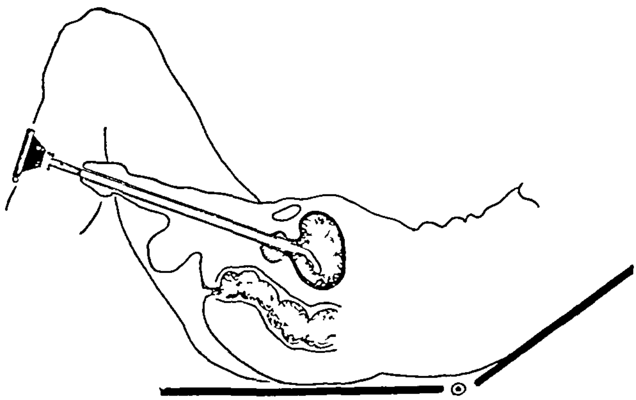


Fig 42 —Correct position of patient on the cystoscopic chair

normal result from flexion or extension of the lumbar spine causing a corresponding rotation of the pelvis and bladder

* Frequently, however, I do not employ the stirrups, as the extended legs are liable to hamper one's movements

Extension not uncommonly occurs when an apprehensive patient involuntarily arches his lumbar spine (*Fig* 43) The pelvis is thrown forwards and in order to maintain the correct relationship of the

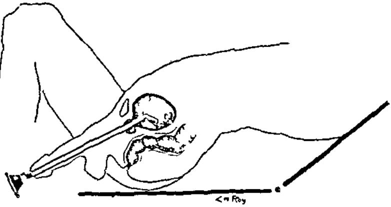


Fig 43—Shows arching of the lumbar spine and the depression of the ocular end necessitated thereby

cystoscope to the bladder, the surgeon is compelled to depress the ocular end inconveniently Even when advised of the desirability of maintaining the correct attitude nervous subjects may do so with

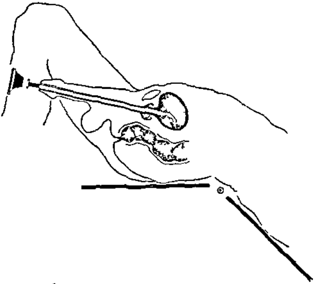


Fig 44—The back of the chair lowered to correct extension shown in *Fig* 43

difficulty but by lowering the head of the chair to a point below the horizontal the trouble may be circumvented (*Fig* 44)

Flexion of the pelvis on the trunk results in the opposite disadvantage The extravesical end of the instrument must now be

elevated until when the bladder base is under inspection, the shaft approximates to the upright, and the surgeon, unable now to be seated, must bend forward to bring his eye into line with the instrument. This position is most commonly seen when cystoscopy is undertaken on an operating table and the patient is thoughtlessly placed in the full lithotomy position, the feet occupying the stirrups and the thighs being strongly flexed towards the abdomen (*Fig* 45). A re-adjustment of the lower extremities will rectify the trouble. The knees should be supported close to and outside the uprights in straps, the legs being allowed to hang free, whilst the thighs take up a position similar to that used on the cystoscopic chair. The inexperienced operator may fail to appreciate the disadvantages additional to the discomforts which this erroneous position entails, and frequently attempts to orientate the bladder with the shaft of the cystoscope in the accustomed horizontal plane (*see* page 57 and *Fig* 53.) As the trigone under these circumstances is placed perpendicularly, he may locate it with difficulty or even fail to do so, whilst catheterization of the ureters and other intravesical operations are rendered unnecessarily difficult. This trivial error is a fertile source of needless embarrassment to the occasional cystoscopist.

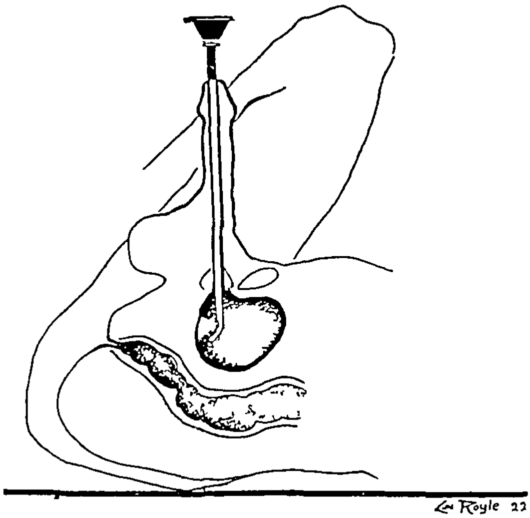


Fig 45.—Incorrect position, with thighs flexed strongly on the abdomen.

Irrigation and Filling of the Bladder.—

Choice of Instruments.—The filling of the bladder may be accomplished either through a rubber catheter or through an irrigating cystoscope. The advantage of the former is that it is a soft and flexible structure causing little discomfort when in position. It would at first sight, therefore, appear to be peculiarly suitable for washing out a viscus when considerable time will probably be taken up in that operation—for instance, one containing much muco-pus—but actually this is not the case. The thick walls of the rubber catheter reduce its bore to such an extent that much time is lost, and the advantage of the thin-walled metal instrument, with its large lumen and fenestra, is most evident in practice. Especially is this so when there are masses of ropy pus lying in the bladder. These are incapable

of escaping through a rubber catheter, but on the introduction of the irrigating cystoscope flow out in quantity, and the bladder is often rapidly cleansed with a few washes It is almost indispensable in bladders which fill rapidly with blood or pus, from whatever source and especially where urethral bleeding fouls the fenestra during introduction An additional advantage with the irrigating cystoscope is that it involves the passage of only a single instrument

In the male the cystoscope, once introduced will be held in position by the fixed parts surrounding the proximal urethra and the surgeon may abandon his hold on it whilst occupying his hands

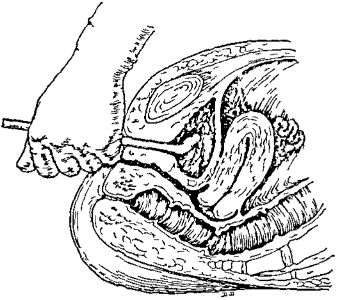


Fig 46 — An assistant holds the cystoscope during lavage of the female bladder and the ulnar border of the hand makes a fixed point of the perineum in order to obviate movements of propulsion and retropulsion Note the degree of advancement of the cystoscope into the bladder which prevents vesical injury (Towels omitted)

with the syringe etc. When working short handed this is very convenient In the female on the other hand the cystoscope must be maintained in position by the operator as the urethra will not support it These facts taken in conjunction with the relative painlessness of urethral instrumentation in women (allowing of the passage of more than one instrument) lead me to use a rubber catheter in that sex where I should employ an irrigating cystoscope in the male I never use the customary glass catheter as bruising of the vesical fundus frequently results The adoption of a rubber catheter in the female has an additional advantage, in that the preparation of selected bladders can be left to the nursing staff and much of the surgeon s own time is thereby saved If assistance is available however the cystoscope is held as shown in *Fig* 46 If the cystoscope is employed to irrigate and fill the bladder it should be introduced with the telescope in position acting as an obturator so that the edges of the fenestra shall not injure the urethral mucosa When

the tip is in the bladder the telescope is removed and the faucet is substituted

Obtaining a Catheter Specimen.—The patient is instructed to pass his urine three hours before he is expecting a cystoscopy, and then to avoid further micturition until after the operation In the case of patients who suffer from frequency of micturition this rule, of course, requires modification Thus, for example, if the period for which the urine can be held is only three-quarters of an hour, he is expected to pass it at that interval before the examination The nursing staff must be trained to arrange for this, which is easier to accomplish for an in-patient than for an out-patient. Though presenting no difficulties when the patient's frequency is normal, or near normal, it is not always so easy to time diseased bladders. It may then call for some intelligence and a sympathetic understanding of the limited capacities of such pathological organs Yet, the obtaining of a proper specimen of urine at this stage is an important feature of a urological investigation, an empty bladder constituting a serious error in technique

The patient, having been routinely cleansed and anæsthetized, is placed on the chair or table The selected instrument is introduced into the bladder, and the urine present is withdrawn This specimen of urine—a catheter specimen—is free from urethral contamination, and is sent to the pathologist for histological and bacteriological investigation It is withdrawn into a sterile glass receiver, and before it is sent away the surgeon, holding it up to the light, carefully scrutinizes it for the presence of pus, blood, or other opacity From the condition of the urine he will acquire indications as to the presence of cystitis, and as to the length of time that the bladder will require to be irrigated before it is ready for cystoscopy A small portion of the urine may also be retained for clinical tests if thought desirable, but it will be remembered that these tests have already been carried out at the patient's first visit to the clinic, so far as a normally voided specimen is concerned Fresh clinical tests would only be required in the event of suspicion that pus or other extraneous material, observed at an earlier examination, was of urethral origin The bladder is completely emptied, the degree of ejaculatory force of the detrusor being noted When this is weak it may be necessary to assist it with manual pressure applied to the hypogastrium

The absence of opacity in the specimen sent to the laboratory would suggest that there was no inflammatory reduction in the bladder capacity, and that the first wash would be returned clear Only a few ounces of fluid are injected, therefore, and on their return are caught in a fresh glass receiver and again examined against the light If the fluid is transparent the bladder is forthwith distended with 8 oz of solution and is ready for cystoscopy

The bladder may be irrigated and distended by means of a syringe a funnel and tube, or a cystoscope with provision for continuous irrigation

Syringe—The syringe which the writer uses (*Fig* 4) is made either with a glass or with a metal barrel The capacity of each is 8 oz and the piston shaft of the metal syringe is marked with notches the distance between each pair representing 2 oz of fluid in the barrel of the syringe so that the quantity in use can be readily observed In the case of the glass syringe the measurements are marked either on the barrel or on the piston A plain barrel is less expensive to replace when broken which is an important matter One advantage

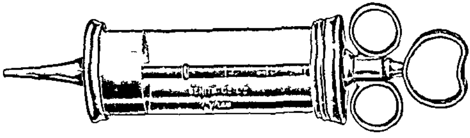


Fig 4 —Glass bladder syringe with tapered nozzle to fit faucet It is graduated on the piston shaft

of a glass barrel is that the presence of air in its interior can be readily detected and remedied A metal barrel is not subject to breakage by knocks or by heat during sterilization but it is made of soft metal and is thin so that any trifling bruise will jam the piston A dinted metal syringe is worse than a broken glass one

The nozzle is conical and is designed to fit accurately into the cone shaped interior of the cystoscope faucet whereby a watertight connection is instantly produced during bladder preparation

The use of a syringe is convenient and accurate One always knows exactly how much fluid has been introduced into the bladder When using the syringe the surgeon should insist that it is handed to him quite full During the filling a certain amount of air is sucked in around the piston and screws this air must be evacuated by turning the point upwards and then raising the piston until the lotion makes its appearance at the nozzle It should then be turned downwards whilst the piston is *still supported* and the remaining portion of the syringe filled If the piston is not continuously *supported* gravity will displace it and air will again be introduced This is a small but important point for often when injecting the last ounce into the bladder a gurgling of air is heard and on cystoscopy a large bubble is found to obscure the apex of the viscus The smaller the bladder the greater the importance of keeping the air bubble small

Funnel and Tube.—I imagine that few experienced cystoscopists now employ this method; it is clumsy and laborious and should become obsolete. It is very difficult to gauge exactly how much fluid has been injected into the bladder—a most important point—and also there is always a large amount of air displaced from the long airway into the bladder, with the result that the air-bubble is undesirably large.

When the bladder is being prepared with a funnel and tube one generally sees the emptying of the viscus performed by inverting the whole of this long water channel over a bucket. A column of fluid with a definite momentum is thus produced. As soon as the bladder is evacuated, the continued movement of this column acts as a water-hammer. A portion of the vesical mucosa is liable thereby to get sucked into the catheter eye and to be damaged. I have frequently noted the kick of the fluid in the tube, comparable to the concussion which one observes in a water-pipe when a tap is suddenly closed. The remedy is obvious, and consists in removing the tube at its junction with the in-lying catheter, and allowing the bladder contents to flow out gently under the action of gravity and the detrusor.

Continuous Irrigation.—Cystoscopes having two irrigation tubes (inlet and outlet) are made. These tubes, especially when applied to the catheterizing model, are of necessity very small, and the jet and outflow are reduced to the point of ineffectiveness so far as maintaining uninterrupted clarity in a bleeding or muddy bladder goes. The outlet invariably gets blocked with debris.

Bladder Capacity.—

Normal Capacity.—The usual capacity of the healthy bladder is from 8 to 12 oz., being rather greater in the female than in the male. It is desirable to distend the organ to a point at which all the folds of mucosa are straightened out, so that every part of the viscus may come under observation. Further than this it is not good to go, as over-distension will lead to restlessness and a desire on the part of a conscious patient to urinate. In the female, therefore, 10 oz. may be used, and 8 oz. in the male. In both sexes, however, I prefer to use 8 oz., as it is good practice to get accustomed to a certain bladder capacity and keep to it. One's ideas of distance, size, and orientation are thereby assisted. Further, in practice it is convenient to use the amount of fluid contained in the 8-oz. bladder syringe.

Large Bladders.—In filling the bladder allowance should be made for any alterations in its capacity which may be indicated by the history. Thus a bladder which has had much residual urine for some long period will take perhaps a pint and sometimes much more of fluid with comfort; it is then necessary to use a larger quantity of fluid in order to distend the folds in the mucosa. At the same time it should be kept in mind that too great a distension will be

inconvenient for it necessitates wide excursions of the vesical end of the cystoscope in an attempt to see all portions of the mucosa

Small and Irritable Bladders—Small quantities of fluid will be used in bladders which are hypersensitive and pathologically reduced in capacity Cystoscopy becomes difficult when the bladder is of very small content and diminishes in value as the size diminishes Finally it becomes impossible with a capacity less than about 2 oz

When pus is present in the first vesical washings it is advisable to proceed with caution in the distension of the organ As a number of washings are certain to be required there is no advantage in commencing with large ones After an evacuation of the bladder therefore a single ounce of lotion is inserted and allowed to return The next wash consists of 2 oz the third of 3 oz, and so on Ultimately the cystoscopist diagnoses the capacity of the viscus When injecting the lotion he watches carefully the effects produced on the patient s respirations If distension is reaching its limit, they are increased in frequency and depth and the patient may also complain of pain or of a desire to micturate Even under general anaesthesia the respiratory reflex is very sensitive and will give valuable suggestions regarding the capacity of the viscus The surgeon now continues his irrigation until the lotion returns clear or as clear as he deems the circumstances will allow During those lavages subsequent to the diagnosis of the vesical capacity he will avoid over distension In practice it is wise to fall short of the maximum capacity by one or two ounces in order that the organ may not be fatigued or irritated When the bladder is finally filled for inspection the distension should be less than the maximum as otherwise it is liable to empty itself before the examination is complete It should be borne in mind that additional fluid is constantly being contributed by the kidney If the examination is commenced with full distension there will not be room to accommodate this extra fluid

Where irritability is extreme it is advisable to avoid emptying the last ounce or so of fluid as it is found that these bladders tolerate interference better if a small quantity is left in at the end of each wash The reason for this is probably twofold First the swollen and hyperaemic mucosa does not easily adapt itself to the completely emptied state and secondly this membrane is brought less intimately into contact with the end of the catheter or cystoscope if an ounce of lotion remains to accommodate it Many bladders containing pus show a normal or more than normal capacity Such a one for instance is the bladder obstructed by prostatic hypertrophy or urethral stricture Nevertheless the technique described has no disadvantages and will frequently be serviceable even in these patients

The source of origin of pus may sometimes be diagnosed by the way the bladder reacts to lavage. If it comes from the kidney, the vesical medium usually clears rapidly under lavage; but when there is a copious supply of pus, as for instance from a pyonephrosis or a tuberculous kidney, it rapidly fouls the bladder again. On the other hand, if the pus is of vesical origin, it is often mixed with quantities of sticky mucus and is therefore very adherent. Further, cystitis has frequently some associated complication, such as false or true diverticula, etc., from which fresh amounts of pus continually recontaminate the organ. Bladder washing may, under these circumstances, be prolonged and require much patience; but once the organ is clear it tends to remain so for at least the duration of the cystoscopy. Pus from the kidney may, of course, infect the bladder, when the above rules would be correspondingly modified.

Hæmorrhage.—Hæmorrhage may show itself during bladder preparation, and its source may be urethral, vesical, ureteral, or renal. The first of these is generally easily overcome by the use of the catheterizing cystoscope.

Vesical Bleeding.—This is frequent, and is usually amenable to gentle manipulations and continuous lavage, over-distension being particularly avoided. Sometimes, when coming from an extremely inflamed bladder, or one containing a neoplasm, it may be very obstinate, and in such cases the more one irrigates, the more profuse the hæmorrhage becomes. If the bleeding is fresh, the wash is a bright pink in colour, whereas old blood is darker and more 'laked.'

Lavage with silver nitrate 1–1000 may control the hæmorrhage, but adrenaline, ½ drachm of the 1–1000 solution to one pint of water, will be found the most certain remedy. When the patient is being cystoscoped under general anæsthesia, and the surgeon is contemplating the addition of adrenaline to the bladder wash, he should advise the anæsthetist of his intention. If the patient is receiving pure chloroform, the injection of this drug carries the danger of adrenaline shock. The change to ether or a mixture of chloroform and ether will remove the danger.

Renal Bleeding.—Blood from the kidney which is lodged in the bladder is usually rapidly washed away; it is uncommon for it to be so profuse that the bladder cannot be prepared for cystoscopy, though that happens from time to time.

When hæmorrhage, whether renal or vesical, has been profuse prior to cystoscopy, clots may have formed in the bladder sump and render the examination impossible. They cannot be washed away; they completely hide the underlying base, the ureters, and any lesion which may exist there; and they persistently exude blood-pigments into the vesical medium and make it opaque. It is then best to

abandon the attempt and to put the patient to bed until the urine is free from blood and has remained so for three or four days. It is wise not to be too precipitate in cystoscoping immediately the urine has cleared, for when the hæmorrhage has been so severe decolorized clots persist, sometimes making it necessary to wait for many days before the conditions are ripe for a successful cystoscopy.

To deal with hæmorrhage which is otherwise difficult or impossible to control, Wardill recommends a technique in which paraffin is used as a medium. The blood, as it is shed, does not mix with the paraffin, so that the medium remains clear and the source can be identified and perhaps dealt with by the cautery. The selection of a proper grade of oil is important, since the ordinary medicinal paraffin is too viscous. Wardill advises one with a specific gravity of about 0·860, which is much easier to handle and which can be obtained from any good chemist. If difficulty is encountered in removing opaque material from the bladder sump, he recommends the use of a sucker.

THE INTRODUCTION OF THE CYSTOSCOPE

Females.—In women the introduction of the cystoscope is easy, as the canal is short, wide, and mobile. The beak of the instrument is introduced in the line of the channel, and as it slips in the shaft is lowered so as to come into line with the urethra. Sometimes the external meatus is small, but it readily dilates on introducing any cone-shaped instrument, as a gum elastic bougie (24 French) or the nozzle of a bladder syringe. These do not need to be passed into the bladder.

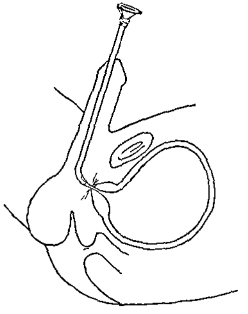


Fig. 48.—Introduction of the cystoscope. Beak ready to pass into the membranous urethra.

Males.—In men the introduction is generally easy if properly executed, but in certain cases it may be extremely difficult. The problem which presents itself is the insinuation of a straight rod with an elbowed extremity through the long narrow curved urethra. Advantage is taken of the fact that the pendulous portion of the penis is mobile in order to bring it into line with the first portion of the fixed urethra. This is done by elevating it fully on to the surface of the abdomen. The beak of the cystoscope is introduced into the

meatus and the shaft is quietly passed down the tube. Movements should be slow, gentle, and steady, the instrument being held lightly in the fingers Rapid or jerky movements cause considerable pain, whilst slow ones are scarcely noticed by the patient The motion should be a combined one in which both hands participate, the penis being drawn well up over the shaft like a glove finger, whilst the instrument is allowed to slide by its own weight down the urethra When the beak approaches the curve of the membranous urethra (*Fig* 48) the passage should be held on the stretch, all folds in which the nose of the instrument might catch being thus obliterated The penis is kept well up over the abdomen until the beak is felt to move forwards towards the prostate, when this occurs the cystoscopist knows that it is in position for the next manœuvre, the nose lying against the triangular ligament and waiting to enter the membranous urethra If he is in any doubt as to its having reached this portion, the left hand may be allowed to relinquish its hold on the penis and may be placed in the perineum, where it will easily determine the correctness or otherwise of the position This should rarely be needed and should, if possible, be avoided If the instrument is not sufficiently close to the compressor urethræ there will be a danger that in the next movement the beak may hitch on the symphysis pubis and bruising of the upper wall of the urethra may result when the ocular is depressed

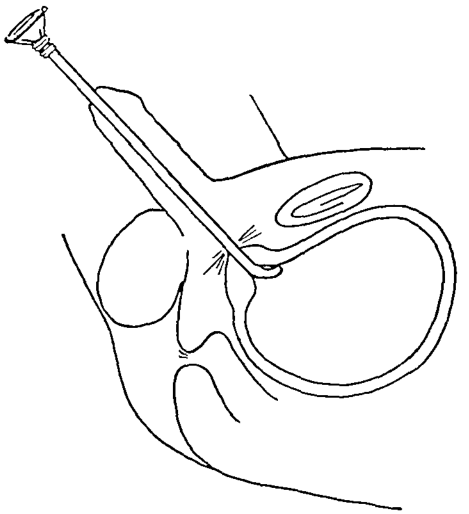


Fig 49 —Introduction of the cystsocope ocular end depressed between the thighs of the patient, the beak entering bladder

During the next stage (*Fig* 49) the ocular is brought down by a circular sweeping motion until it comes to lie between the thighs of the patient Lightness of touch throughout this manœuvre is paramount During it the beak slips through the pursed-up aperture in the compressor urethræ and passes along the prostatic urethra into the bladder As the beak enters the prostatic urethra it lies approximately in the line of this portion of the passage, but when the shaft follows a tilting back or retroversion of the gland occurs through the channel being straightened out (*Fig* 50 A and B) The gland constantly tends to return to its normal position, so that it will easily be understood that there will be two points of pressure in this section

of the urethra situated respectively on the postero superior and antero inferior region of the prostatic urethra These two points together with the orifice in the triangular ligament and the suspensory ligament of the penis are the sites of tension in the male urethra during cystoscopy In enlargement of the prostate gland there is usually an alteration in the line of this section such that the angle made with

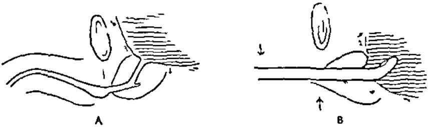


Fig 50 —A Normal male urethra prior to introduction of cystoscope B The same after introduction of cystoscope Note the straightening out of the canal To permit this the prostate is retroverted—anterior end slightly elevated posterior portion considerably thrown back

the rest of the canal is increased When therefore the cystoscope is introduced in prostatic hypertrophy there will be a very considerable amount of retroversion of the prostatic gland (*Fig* 51 A and B)

Failure to pass the instrument may result from its becoming caught on the symphysis pubis when a return to the first position will be necessary so that the beak may be passed further down into the

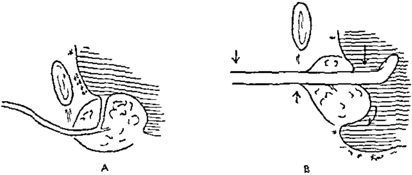


Fig 51 —A Male urethra in prostatic hypertrophy Note increase in the curve of the prostatic urethra as compared with the normal (*Fig* 50 A) B The same after introduction of cystoscope Marked retroversion of prostate causing exaggeration of the retroprostatic pouch

bulbous urethra Again it may have caught in the dilated cul de sac of the bulb when one or two lateral movements will generally release it Obstruction may also be due to the ocular extremity not having been sufficiently depressed between the thighs of the patient, in which case if the cause is recognized the remedy is easy

Pathological conditions giving rise to trouble are stricture of the urethra and prostatic hypertrophy The former will be recognized

when skilfully applied movements remain unsuccessful. Many surgeons explore the urethra a day or two prior to the cystoscopy in order to exclude this possibility, but, as has previously been stated the present writer considers this to be undesirable. The presence of a stricture should, however, be confirmed by the use of bougies. If a stricture is present it may be dilatable, size 21 F. being required for an examination sheath, size 22 or 23 for a catheterizing one. The aero-urethroscope should never be employed immediately following a failure at cystoscopy, as bruising of the mucosa may be present and fatal air embolism result from air distension.

Difficulty arising from prostatic hypertrophy can usually be overcome by further depressing the ocular and by elevating the vesical end with a finger on the perineum, so that the beak hugs the upper urethral wall closely. Experience shows that the postero-inferior wall is very susceptible to trauma in this condition and that hæmorrhage may be excited by insignificant injury, whilst the converse is true of the upper wall. In introducing the instrument, therefore, the beak should be made to hug the antero-superior wall by the means above described.

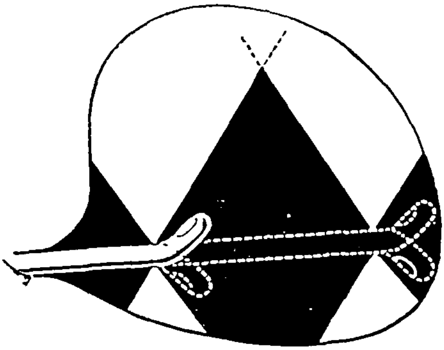


Fig. 52.—Cystoscope in the primary position. Note the distances from the base and vault respectively. The movements of introduction and withdrawal are also shown.

As soon as the instrument has entered the bladder it slips along more easily so that the cystoscopist is aware of its having reached its destination. It can now be rotated freely round its own axis owing to the elbowed end having escaped from the confines of the urethra into the more generous spaces of the bladder. As it slides into this viscus the cystoscope occupies a similar position relative to the bladder cavity in both the male and female. In the female it lies in a direct line with the undistorted urethra. In the male it takes up a position which is the resultant of the pressures exerted upon it by the straightened-out curves of the urethra. The fixed points of the urethra virilis correspond, as previously stated, to the suspensory ligament of the penis, the orifice in the triangular ligament and the retroverted prostate. These points tend to hold the instrument in a fixed position, which in the future will be referred to as the *primary* position of the cystoscope. It is represented in *Fig.* 52 and should be noted with care, for it is from this starting-point that the operator begins his investigations. Note that the instrument where it rests in the meatus lies close to the floor of the bladder, and that there is a

gradual declination of the bladder base as it is traced posteriorly At no point however does it lie more than ¼ in to 1 in away from the line occupied by the cystoscope when in this primary position Note by contrast the relationship of the other walls of the viscus In front it will be observed that the anterior wall rises steeply from the meatus and that its more distant portion together with the rest of the vesical dome is much removed from the fenestra of the instrument when held in this line The importance of these facts will become evident when the method of examination of the bladder is described

THE EXAMINATION OF THE BLADDER

The cystoscope is now in place and the fenestra and lamp are facing upwards as indicated to the operator by the position of the knob on the ocular end of the instrument The operator seats himself opposite the end of the cystoscope on a low chair or stool—the standard theatre stool is too tall for comfort The chair is placed close to the patient so that the examination can be conducted in comfort The electric coupler is attached and the light switched on

The student should accustom himself to holding the cystoscope correctly it is steadied by means of the electric coupler held in the left hand in a dependent position All the rotary movements of the cystoscope are performed by the right hand the instrument revolving around its attachment to the coupler A finger of this hand constantly strays towards the knob or indicator at the ocular end and by its means the operator is kept informed as to the direction in which the fenestra is looking

There are three chief movements which can be imparted to the cystoscope and it is by combinations of these that all the various segments of the viscus can be successively scrutinized they are (1) *Movements of introduction and withdrawal propulsion and retropulsion* (2) *Rotation*, (3) *Pendulum or see saw movements*

1 **Introduction and Withdrawal** (*Fig* 32) —The cystoscope moves in the line of its own long axis In extreme withdrawal or retropulsion the fenestra lies just on the margin of the internal meatus In extreme propulsion the beak is in contact with the posterior wall of the bladder By these movements any single strip of the bladder mucosa lying in the sagittal plane may be surveyed—the strip lying on the inferior superior or lateral wall according to the position of the fenestra

2 **Rotation** (*Fig* 33) —In the movement of rotation the cystoscope revolves around its long axis When it occupies the primary position circular bands of the mucosa can thus be inspected It should be noted however that in this primary cystoscopic position

the bands vary in character in different parts of the organ, for in the inferior part, to which the instrument lies fairly close, the band will be narrow, brightly illuminated and the image clear and highly magnified whereas on the upper parts, from which it is far away the band will be broad, badly illuminated and the image indistinct and little or not at all magnified, or in exceptional circumstances even diminished (*see Fig* 12 and related text, page 13) It will therefore be impossible adequately to examine these latter areas with the cystoscope in the primary position, and secondary movements must be undertaken to bring them into view. These are known as —

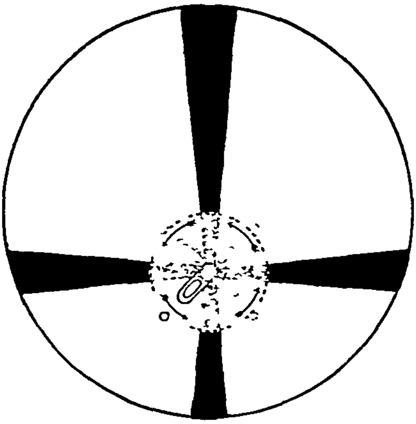


Fig 53 —Movements of rotation of the cystoscope on its long axis The shaft of the instrument occupies the primary position and is therefore excentrally placed as regards the bladder

3. Pendulum or See-saw Movements (*Fig* 54) —By these the instrument rocks around the neighbourhood of the neck of the bladder as a fixed point or pivot so that when the ocular is carried in one direction the beak approaches the opposite bladder wall Thus if the ocular is depressed, the beak is elevated, if carried towards the left thigh the beak approaches the right side of the bladder In all these pendulum movements the degree of motion which it is necessary to impart to the ocular in order to get a given range of movement by the objective will depend on the point at which the shaft of the cystoscope rests in the bladder neck —that is the relative amounts of the intravesical to the extravesical portions of the instrument The distance from the ocular to the objective is usually about 12 in, if therefore the shaft could be gripped at a point midway between the two lenses, a given movement of the ocular would determine an exactly similar range of movement for the objective, but in the opposite direction If it is held at a point 1 in. from the objective, an 11 in. range of movement will have to be imparted

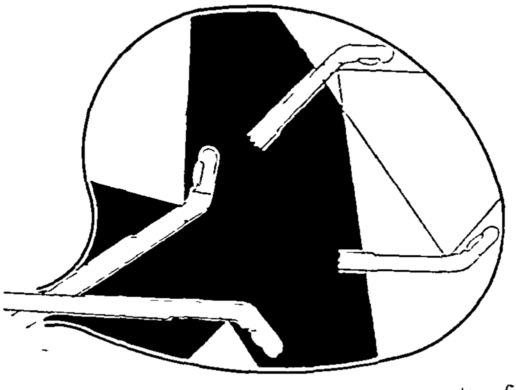
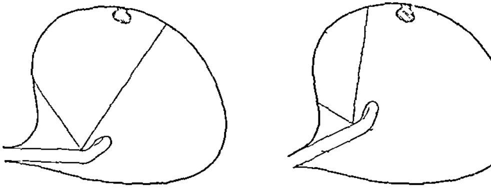


Fig 54 —Showing rocking movements of the cystoscope, and also methods of examining the fundus of the bladder

to the ocular to gain a 1 in movement of the fenestra This must be borne in mind when examining the various parts of the organ if the fundus is being inspected upwards of 4 in of shaft lie in the bladder cavity If on the other hand the neck is being examined less than ½ in may lie within the viscus It is obvious that to gain a given excursion—say ½ in—near the neck a much smaller sweep would be required by the ocular than that which would be needed for a similar movement in the fundus

The advantages which accrue from rocking movements are the result of the greater approximation of (a) The light whereby the



A B

Fig 55 —A An object seen in the distance through the cystoscope B Rocking movements of the cystoscope throw it out of the field of view To recover it the instrument must be pushed farther into the bladder

intensity of illumination is enhanced and (b) The fenestra whereby magnification is increased As a general rule these movements have to be associated with that of propulsion *Fig* 55 illustrates the reason for this It will be seen that an object which has been observed from a distance and which it is desired to inspect more closely is thrown out of the field by a simple pendulum movement and that the instrument must in addition be pushed farther into the bladder in order to bring it into the field again (propulsion)

Reasons for Seeing Nothing in the Bladder—It happens sometimes that when the eye is applied to the ocular no field of view is discernible This may be due to some defect in the lighting which has taken place in the short time which has elapsed since the cystoscope was examined A quick inspection of the various connections should be made to ascertain that the contacts are good but the instrument should not be hastily withdrawn from the bladder to make sure that the lamp is still burning

Fig 56 illustrates several circumstances capable of accounting for a darkened field The fact that the prism is still in the urethra may be the cause (*Fig* 56 A) Conversely the beak of the cystoscope may

be sunk in the posterior wall of the bladder and its light will be shaded thereby (*Fig* 56 B) In the same way it may be embedded in a neoplasm (*Fig.* 56 C) or be in too close contact with a stone (*Fig* 56 D) Sometimes the vesical cavity is misshapen, usually as the

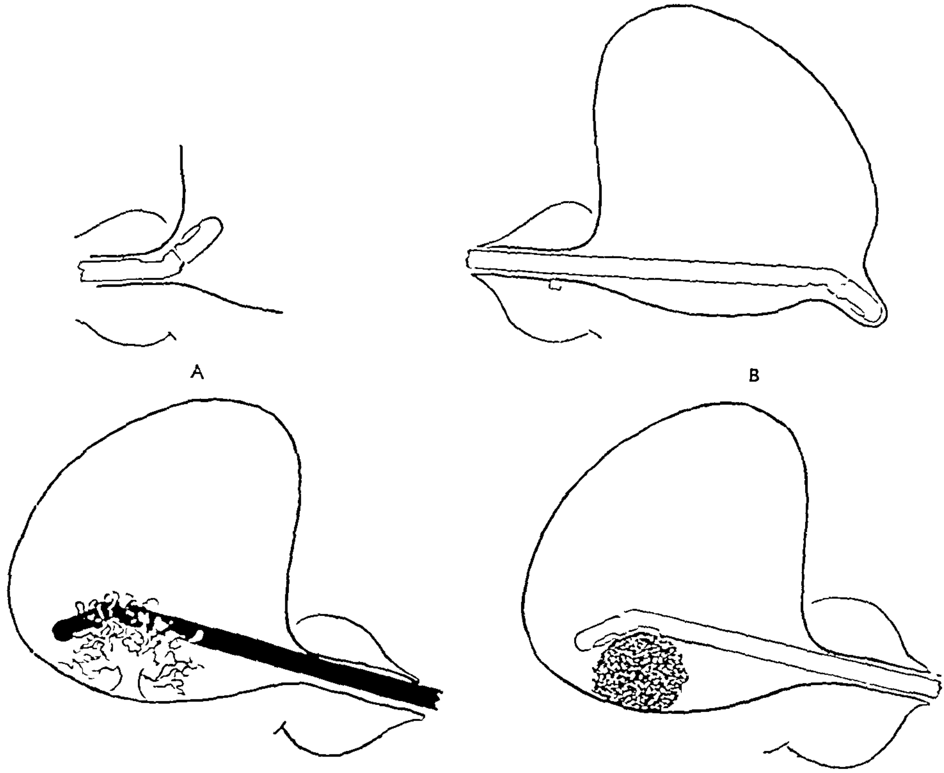


Fig 56 —Four reasons for seeing nothing in the bladder A, Window still in the urethra , B, Beak of cystoscope sunk in posterior wall of bladder , C, Beak of cystoscope embedded in neoplasm D, Prism and lamp in close contact with a stone Fields of illumination and of view do not correspond

result of extrinsic causes Prominent amongst these may be mentioned the mechanical results of change in the shape or position of the uterus (Chapter XIX) Thus the posterior wall may be bulged in by the gravid or fibromatous organ and the cavity may at some points be obliterated by its anterior and posterior walls coming into contact, whilst the bladder s position and shape may be greatly altered by uterine prolapse Tumours arising in organs other than the uterus—for instance an ovarian cyst or a large vesical diverticulum—may similarly distort the bladder and impose obstacles to orientation

When this type of difficulty arises the surgeon unaware of the exact cause of his trouble should attempt to discover some point in the viscus which is illuminated, however indistinctly From this partially

lit base he should move warily If the darkness returns he will retrace his steps and make a fresh start in a new direction Movements of rotation withdrawal etc, will be alternately tried Eventually a satisfactory field will probably be discovered and from this he will get his bearings and be able to trace some considerable extent of the bladder He will ultimately return to investigate the object of his original trouble If after a fair trial, no illumination can be made out in the bladder the cystoscope will be withdrawn to make certain that the fault does not lie with it

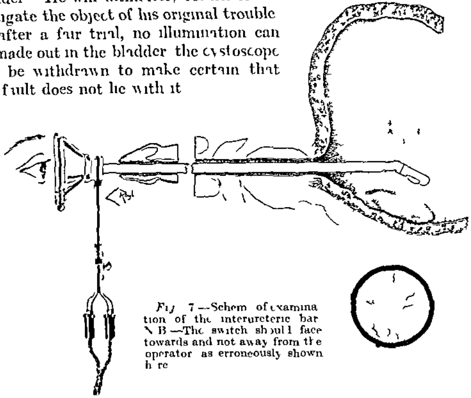


Fig 7 —Scheme of examination of the interureteric bar N B —The switch should face towards and not away from the operator as erroneously shown here

Orientation of the Bladder —Some urologists commence the examination of the bladder at its uppermost point It has already been shown that the objective lies a considerable distance away from this point when the cystoscope is held in the *primary* position the result being that illumination is poor and magnification defective This is in fact one of the more difficult areas to examine and in order to see it efficiently wide excursions of the instrument must be resorted to It is recommended therefore that the cystoscope be turned over and that the inferior wall from which it is distant only about ½ to 1 in be examined in the first place (Fig 37) The illumination and magnification will there be found good without any pendulum movements of the instrument so that the examination can be easily and rapidly started The cystoscopist gets his bearings immediately and finds a point from which he can trace the remaining walls of the viscus

By adopting this order the most interesting and important parts of the organ are inspected first A large majority of bladder lesions

are situated in the base, and it is often advantageous to examine it first as thereby one obtains an early indication of any pathological condition which is present Particularly is it important in the case of a restless patient or one with an irritable bladder, when speed may be essential for if time is unnecessarily lost in examining the less important regions the viscus may empty itself involuntarily before the diagnosis is complete Similarly in dealing with those conditions in which the medium quickly becomes clouded with blood or pus it is advisable to commence in this vital area. The only danger of the method is that the remainder of the bladder may be neglected, the finding of a lesion in the lower part so occupying the mind of the investigator that the possibility of another lesion situated in the upper segment is forgotten

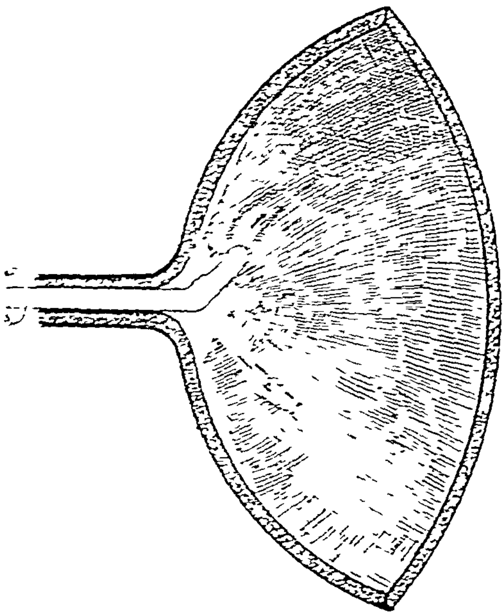


Fig. 38—Method of inspecting the bladder neck Note that the vesical orifice *and portions of the bladder* mucosa in the region of the neck are contained in the same cystoscopic field, and that they vary considerably in the distance to which they are removed from the fenestra and therefore in the quality of their illumination and magnification (cf *Plate I*)

The indicator of the cystoscope is therefore rotated until it lies midway between the vertical and horizontal and an area of the bladder wall comes into view which is as a rule, in the neighbourhood of, or just posterior to one of the ureteric orifices This point is examined and the instrument is made to rotate slowly on its long axis, the indicator moving in a pendulum fashion to a corresponding point on the opposite side each area of the mucous membrane meanwhile being carefully scrutinized as the fenestra moves across The strip thus examined is the retrotrigonal portion of the bladder, or 'bas fond'. The cystoscope is now slightly withdrawn in the direction of the operator and a second strip lying just anterior to the previous one is examined. As it passes across the base of the viscus this time the interureteric bar and the two ureters together with the portions of the wall lying immediately external to these structures, will be seen When they have been examined successive bands lying closer to the meatus are similarly examined the cystoscope being withdrawn a distance of about $\frac{3}{4}$ in for each strip Finally, an area of the bladder lying just within the meatus and corresponding to the most anterior portion of the trigone is inspected

Examination of the Internal Meatus.—If the instrument is now withdrawn another short distance the fenestra will come to lie actually within the meatus and the field will become darkened as the result of its being covered by the mucosa of the urethra. A small amount of manœuvring will bring it into such a position that the anterior half lies within the urethra and the posterior half lies in the bladder cavity (*Fig.* 58). When this is done a translucent line will be seen to pass across the field of vision (*Plate I* C, page 68). Behind it the field is illuminated, whilst in front of it, it is dark. This translucent line represents the internal meatus and the shape of the whole orifice is readily appreciated if the cystoscope is rotated so that the margin is successively examined in its whole circumference. In the normal state it shows itself as a concave shadow (*Fig.* 59) perfectly regular in the upper four fifths of the circumference but slightly flattened or even convex in the lowest fifth, where it is in relation to the trigone. Any alteration in the shape of this line would indicate an abnormality except that in the case of the female folds or rugæ may quite commonly be seen apart from any pathological condition (*Plate I* D). The commonest morbid variation seen is in hypertrophy of the prostate, when one or more lobes of that organ obtrude themselves upon the bladder cavity and show a convex in place of a concave margin (*Plate XII* A and B, page 272). Occasionally also some inflammatory process involves the sphincter of the bladder and causes irregularity there. Alterations of the shape of the sphincter are appreciated by the cystoscope only when they affect it in the sagittal plane of the body (*Fig.* 60). Those which lie in the transverse body plane—that is, which bulge towards the urethra—cannot be perceived by this instrument as their only effect is one of magnification. They require a posterior urethroscope for their demonstration (*Fig.* 61).

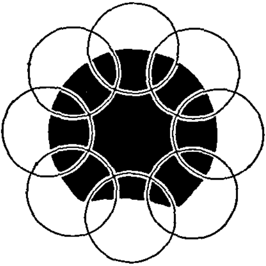


Fig. 59.—Series of cystoscopic fields collectively showing the contour of the internal meatus as the instrument is rotated on its long axis. The orifice is circular save at the lowest point where it is flattened or slightly convex.

Examination of the Bladder Walls.—Having now examined the sphincter we pass to the anterior, upper, lateral and posterior walls. The best way is to start with the anterior portion and to examine consecutive transverse bands from before backwards pretty much in

the same way as strips of the base were examined in the first instance Each successive rotation of the cystoscope, which must now be combined with rocking movements will be made to take in an area of the bladder wall extending down the lateral walls so as to overlap those portions of the base which were first examined

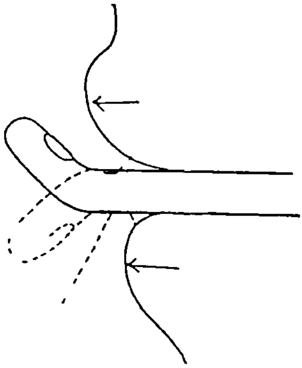


Fig 60 —Cystoscope examining prostatic hypertrophy appreciates increase of the gland occurring in the sagittal body plane

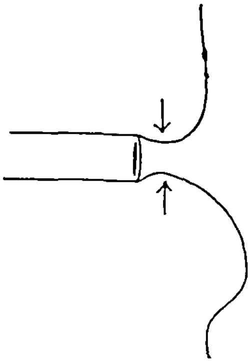


Fig 61 —Urethroscope examining prostatic hypertrophy appreciates increase of the gland occurring in the transverse body plane (cf *Fig* 166, p 277)

To examine the anterior wall closely it will be necessary to depress the ocular deeply between the thighs of the patient so that the fenestra may be brought into comparatively close apposition with this wall of the bladder, which ascends steeply into the retropubic region (*see Fig* 54) This is perhaps the most difficult area to bring into view, and indeed it is occasionally impossible to do so successfully When examining the upper wall the cystoscope must again be deeply depressed though not to such an extent as in the case of the anterior

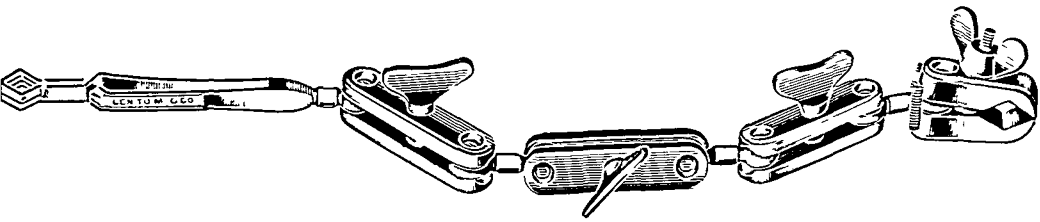


Fig 62 —Canny Ryall's cystoscope holder For steadying the instrument when intravesical conditions are being demonstrated or are under prolonged inspection, as when being drawn

wall, whilst for purposes of examining the lateral walls the ocular must be carried over towards the opposite thigh of the patient These manœuvres will bring into view successively every portion of the viscus, with the exception perhaps of a small area high up on the fundus which can be inspected in the two alternative methods depicted in *Fig* 54

The whole of the bladder has now been brought under observation, and if any lesion has been found the cystoscopist may repair to that lesion and review it in detail. A cystoscope holder (*Fig* 62) may be used for steadying the instrument during the prolonged inspection of some special part of the bladder. In practice it is far from easy to fix an object in the cystoscopic field and even more difficult to retain it there. Whether or not a lesion has been found in the bladder, the surgeon will now study the ureteric orifices more closely in order to obtain any evidence they may offer as to the condition of the upper urinary tract (*see* Chapter XXII)

Variations in the Shape of the Bladder due to Different Degrees of Distension.—The shape of the bladder is governed by its distension (*Fig* 63). When filled it is an irregularly rounded viscus, but as *evacuation proceeds the roof sinks down to meet the base* leaving long anterior and posterior limbs in which the mucous membrane of the vault has come into contact with that of the section lying opposite to it. The roof as seen from outside becomes flattened or even concave. The changes produced in the interior of the organ will be easily realized from examination of Fig 63. The bladder occasionally discharges itself during cystoscopy. As it does so, one of the alterations first remarked by the operator is the diminution of space between the roof and the base. This is most evident in the neighbourhood of the fundus and at the junction of the anterior and superior walls of the viscus. Eventually transverse sulci form in these situations. The portion of the cavity overlying the trigone and ureteric orifices is the last to be obliterated. As the organ becomes emptier its mucosa becomes more wrinkled in order that it may be accommodated in the diminished space. If Fig 63 is compared with *Fig* 67 page 90 the important differences between the physiological and pathological methods of producing reduction in the size of the bladder cavity will become evident

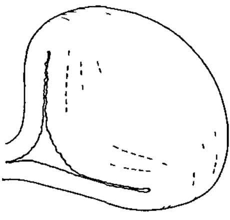


Fig 63—Shape of the bladder as altered by various degrees of distension (*Modified from Poirier and Charpy*)

CHAPTER IV

THE NORMAL BLADDER

THE MUCOSA

THE normal vesical mucosa is a bright, even, and clean-looking membrane (*Plate I* A) Its surface in health is devoid of obvious secretion, is smooth in texture, and reflects light well A dull, granular, or non-reflecting surface, or the presence of secretion is evidence of pathological change

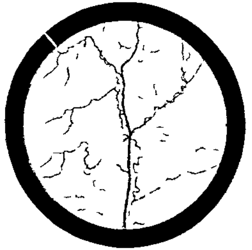
Colour.—The colour of the membrane is sandy-yellow, but when the illumination is poor it may look brownish Here and there where

PLATE I

A, Normal bladder Note main arterial stem accompanied by corkscrew like satellite vessel, also the reflection of light from the prominent margin of the vessels B, Deep recess at the site of the urachus C, Neck of normal bladder in the male (right side under examination), margin regular and even D, Neck of normal bladder in the female (antero superior area being examined) In C the bladder neck is illuminated and the interior of the viscus is in shade In D this is reversed The appearance is due to the relationship of the lamp and not to any difference between the sexes E, The air bubble F, The trigone Note the deep coloration and the high vascularity The interureteric bar is seen crossing the upper third of the picture

it is specially vascular it is flecked with pink and in the shaded areas may develop a purplish tinge The coloration varies slightly in different individuals and in different parts of the same viscus, pigment being specially developed near the outlet The brightness with which the cystoscope lamp is burning affects the vesical colour tone—a statement which can easily be confirmed by varying the position of the control on the rheostat The coloration provided by the modern filament lamp is paler and brighter than that of its predecessor, the carbon filament The medium selected by the operator also influences the colour thus with oxycyanide of mercury it appears yellower than when plain water or boracic is employed , but—more important than this—a small amount of blood in the vesical fluid will give a red tinge to the viscus which may be misinterpreted by the uninitiated as an inflammatory manifestation

Blood-vessels.—At varying intervals blood-vessels, particularly arteries, appear irregularly and radiate close beneath the mucosa, where they may be clearly seen In most fields one or more of these parent stems are to be observed running for longer or shorter



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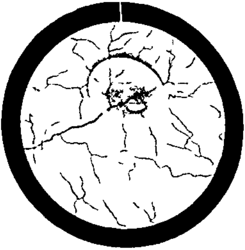

E


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F

distances Frequently a vessel will pass through several cystoscopic fields before breaking up into a number of delicate arterioles The main stems may run a fairly straight or a wavy course Careful inspection will show that some of them are closely accompanied by a vessel of slighter calibre which twines about them with an irregular corkscrew like course and is first seen on one side and then on the other (*Plate I* A) The main vessels or their terminals may pass over or under neighbouring arterioles, and anastomoses between the terminals of the various systems occur

The vascularity of different sections of the bladder varies considerably, the trigone being the most and the lateral walls and apex the least, vascular In the neighbourhood of the ureters one or two important stems may generally be observed which appear actually to emerge from the orifice Veins are also to be seen but are less numerous more deeply placed and larger than the arteries Through the mucosa they look to be of a greyish blue colour and they may run a slightly tortuous course

THE BLADDER MUSCULATURE

Beneath the membrane appear strands of the inner muscular coat of the bladder In ordinary circumstances they are few in number but they elevate the mucous membrane in little ridges, with edges which are clean cut fairly sharp and often sickle shaped They cast a shadow on the neighbouring mucosa They are better developed in old age than in youth and are least obvious in childhood If the bladder is over distended and especially if the patient is straining to urinate they become more numerous and more evident They may also be seen when a bladder is under distended particularly in the female A distinction must be made between this normal trabeculation and that of vesical hypertrophy as seen in cases of stricture prostatic hypertrophy and in certain nervous lesions These conditions will be described in Chapter X

THE TRIGONE

The lowest and most anterior portion of the bladder presents an area differing widely in structure and appearance from what we have described above It is known as the trigone (*Plate I* F) The three orifices of the bladder constitute its angles and it forms an equilateral triangle of which the internal meatus may be conveniently considered as the apex whilst the two ureteric orifices lie at each end of the base Each side of this triangle is about 1½ in long and is formed by a muscular band The band constituting the base is known as the interureteric bar 'torus uretericus or sometimes as the bar of Mercier The bars which pass from the ureter to the

internal meatus are known as the ureteric bars. They were first described by Sir Charles Bell and are known by his name The bars of Bell are better marked than is that of Mercier Under cystoscopic examination they appear to run in the line of the ureter and towards the cystoscopist, being in fact a continuation of the fibres of the ureter which are receiving insertion into the bladder and urethra Though they vary considerably in development, they are, as a rule, easily recognized during cystoscopy In this they contrast with the interureteric bar, which is feebly developed in about 30 per cent of cases and frequently cannot be recognized as an elevation

The shape of the trigone is not constant In some cases its sides are straight, in others they are concave inwards, the trigone then presenting a Y-shaped appearance Generally the various sides are equal in length, and the ureters are placed at equal distances from the internal meatus, and are also equidistant from the midline of

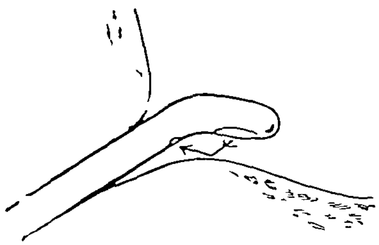


Fig 64 —Examination of the most anterior area of the trigone Note approximation of fenestra to object, which produces a high degree of magnification, also the oblique way in which the light is reflected from the membrane to the prism, often resulting in a sheeny appearance Cystoscope tilted to obtain distance between the mucosa and fenestra

the bladder Occasionally, however, this is not so, one side of the trigone being more developed than the other so that the ureter is displaced

The mucosa which covers this region is smooth in texture and never exhibits the trabeculation which is seen in other portions of the bladder It is highly vascular, the vessels lying immediately underneath the mucous membrane and radiating in a fan-shaped manner from the internal meatus towards the ureters and the interureteric bar (*Plate I* F) As they approach these structures they diminish rapidly in number and finally vanish into the normal structure of the bladder mucosa Both arteries and veins are present and can to some extent be distinguished Occasionally the veins are tortuous and prominent

The cystoscopic appearance of the trigone is a stumbling-block to the inexperienced, who at first mistake its high vascularity for inflammatory hyperæmia, but considerable care must *always* be exercised in interpreting appearances in this region A reference to *Fig* 64 will show that the beak of the cystoscope in examining the extreme anterior part of the trigone lies very close to the mucous membrane, this produces high magnification of the structures (*see* page 16), so that even the smallest irregularity will become greatly exaggerated

and simulate a pathological lesion By depressing the ocular steeply between the thighs of the patient the fenestra may be carried away from the mucous membrane to some extent, and will then give a truer picture of the condition When the cystoscope is held close to the mucosa not only will the magnification be high but the rays of light which reach it from the lamp will approach the surface obliquely (*Fig* 64), with the result that a sheeny or translucent appearance is imparted to the membrane

NOMENCLATURE OF OTHER PORTIONS OF THE BLADDER

The nomenclature adopted for the bladder by cystoscopists is slightly different from that employed by anatomists An interior view of the organ is shown in *Fig* 65

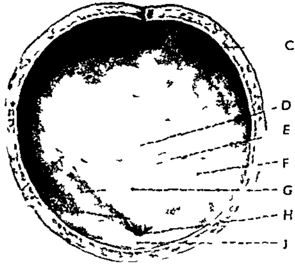


Fig 65—Interior of bladder A Lateral wall B Ureteric bar C Fundus D Retrotrigonal recess or bas fond E Interureteric bar F Lateral recess G Trigone H Internal meatus J Anterior wall

Retrotrigonal Recess or Bas Fond—Immediately behind the trigone is a recess or hollow of somewhat variable development It is bounded in front by the interureteric bar—posterior limit of the trigone—and externally by the most posterior portion of the ureteric bar In a backward direction this area merges insensibly into the posterior wall of the viscus which is known as the *fundus* of the bladder

External to the ureteric bars are recesses lying between those structures and the side wall of the bladder which will be referred to in this book as the *lateral recesses* of the bladder They are better developed in the female than in the male probably owing to the different support afforded by the underlying structures in the two sexes In the female the rounded anterior surface of the uterus elevates the central portion of the bladder but leaves the lateral area

unsupported, whilst in the male the vesical floor is in relation to the prostate and seminal vesicles and is more evenly sustained by them

The depth of both the 'bas fond' and the lateral recesses depends partly on the elevation of the trigone and the development of the ureteric and interureteric bars, which varies considerably. They are also better marked when the bladder is well filled

URETERIC ORIFICES

The ureteric orifices lie at the angles of the trigone and are mounted on the elevation where the ureteric and interureteric bars meet. Ability to recognize them is indispensable, they are, in fact, the most important points of repair in bladder examination Their appearance gives information about the condition of the corresponding kidney or ureter, pathological changes showing themselves in many ways, such as excessive activity, hyperæmia, œdema, ulceration, malformation, emission of blood or pus, and the like

PLATE II

A, Both ureters, left side very small B, Efflux seen from in front C, Efflux seen from side Orifice erect D, Small orifice obscured by numerous blood vessels E, Unusual but normal orifice at rest F, Same orifice in efflux Retraction marked

The Appearance of the Normal Ureter.—This varies considerably, and several types could be portrayed. A representative one will be described, and then the variations from this outlined

The ureter passes through the vesical muscle and mucous membrane obliquely, and the most usual cystoscopic appearance is that of a sloping, tunnel-shaped orifice leading upwards and outwards through the mucosa (*Plate II* A and C), the anterior wall being deficient for a greater distance than the lateral ones, which rapidly shelve down to become confluent with the surrounding bladder base Frequently a number of blood-vessels ramify in its vicinity, some stout twigs actually emerging from the ureteric orifice, whilst others correspond to the ordinary vascular ramifications of the bladder wall In general the coloration of the meatal lips is sandy and similar to that of the rest of the bladder wall, but frequently, without any departure from the normal, there is a delicate purplish coloration due to more generous capillary development This often goes hand in hand with a semi-transparent, pellucid appearance of the lips

Any one of the characteristics of the normal orifice may fail, or be over-developed, without pathological significance—thus —

Size—The size is quite variable, punctiform orifices often being seen, as are also unusually large ones

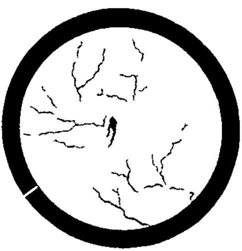
Position—The orifice is generally on the front surface of the muscular eminence, but it may frequently be seen on the outer lateral

PLATE II

THE NORMAL URETER

A

B



C

D

E

F

aspect As before mentioned the opening on the ureteric bar may be nearer to the internal meatus than usual More extreme variations, such as its occupying the centre of the trigone or ending in the urethra are to be regarded as congenital malformations

The Eminence—This is frequently under developed the ureter opening on a flat surface The converse also occurs when it emerges on the summit of an exaggerated elevation

Shape—Variation in the shape of the meatus depends on the degree of development of the lateral folds or lips When these are thin and slight a wide mouthed patulous horseshoe shaped opening results when on the other hand they are of generous size, and especially if they meet below the orifice is slit like, or shuttle shaped the lips being so well evolved that the opening is encroached upon

Vascularity—The depths of the orifice reflect a warm purplish glow, due to its vascularity and in some instances where the lips are ill marked this may be the sole evidence of the presence of the ureteric orifice To the experienced eye it is evident because it lies in the correct position and direction It may be mistaken for a blood vessel but its length purplish hue absence of branches together with the fact that it is somewhat shuttle shaped and that its edges are not clearly defined but fade gradually into the surrounding mucosa serve to distinguish it When lying in a vascular area however it may be difficult to detect (*Plate II* D)

Each of these variations is quite common and they can be seen in all possible combinations Further particularization is unnecessary the important thing is that they shall be recognized as types of the normal and not accounted as pathological

The *efflux of urine* from the orifice confirms the belief that a structure which has been under observation is in fact the ureter When it is about to eject a quantity of urine into the bladder it gathers itself together with a slow vermicular movement its lips become rigid and erect and the orifice closes slightly for a time It then somewhat rapidly relaxes a jet of fluid is shot into the bladder cavity and the ureteric region reverts to its previous resting condition The novice often experiences difficulty in discerning the swirl of the efflux It has been likened to the appearance seen in water when a drop of glycerin is placed in it A representation of the act is shown in *Plate II* B C and F

The *distance between the two ureters* is $1\frac{1}{2}$ in in actual measurement This diminishes slightly as the bladder is emptied though the trigone takes a minor share in contraction When the bladder is distended and the surgeon is examining this area the cystoscopic magnification will give him the impression that the distance between the ureters

is greater than it actually is, they will, in fact, probably appear to be separated by about 2½ to 3 in If, therefore, one ureter has been found, the second ureter can usually be discovered by rotating the cystoscope over an interval of bladder wall which appears to be about 2½ or 3 in in extent In some cases both ureters are inserted nearer to the meatus than normal, in which event they should lie at a point nearer to each other and thus maintain the equilaterality of the triangle

Finding the Ureter.—It is necessary to be able to hunt intelligently for the ureter and to recognize it when seen This latter is not always easy, but becomes easier as experience is gained It should always be possible to find the ureter in a healthy bladder, but diseased organs will present themselves in which it seems quite impossible to discover the orifice It may be lost in excessive vascularity or ulceration, or hidden by neighbouring recesses or diverticula It may be covered by blood or pus, stone or growth If one ureter can be found, it is generally possible to discover the other by the method above described—that is by rotating the cystoscope on its long axis through a number of degrees corresponding to a distance of about 2½ in, whilst avoiding any movement of propulsion or retropulsion

The order of procedure which was recommended above for investigation and orientation of the bladder should discover the ureters early in the operation If they are not quickly seen, the cystoscope may be withdrawn almost to the internal meatus and then pushed back into the bladder along the line of one ureteric bar, examining closely all the way for pits and depressions which may prove to be the object of the search The orifice should be situated where the ureteric and interureteric bars meet If therefore the latter can be identified, it should, when followed to its extremities, lead to the position of the meatus If after a search the ureter still remains unrecognized, recourse may be had to indigo-carmine injected intravenously A portion of this is excreted by the kidney and on reaching the bladder can be recognized as a blue jet (*see Plate XIV* D, page 368) Its site of emergence will indicate the position of the ureteric opening Indigo-carmine should not be used until the bladder examination is otherwise complete, as the dye, if copiously excreted, will quickly render the vesical contents opaque

Internal Meatus—A description of the cystoscopic appearances of this structure is given on page 65

MOVEMENTS OF THE BLADDER WALL

Movements of the bladder wall are frequently observed during cystoscopy and result from varied intrinsic and extrinsic causes

Intrinsic Causes.—The most commonly observed intravesical movement of all is that seen at the ureteric orifices during the efflux

of urine just described. Contractions of the bladder musculature have already been noted, and are chiefly seen when the patient is conscious of an impulse to urinate.

Extrinsic Causes.—Intestinal peristalsis is occasionally seen through the vesical wall precisely as it may be through thin abdominal parietes. Pulsation from the great vessels may be observed in thin and nervous females, and in cases of arteriosclerosis and aneurysm. It may also be seen in tumours of the bladder, uterus, or other pelvic organ. Under ether anæsthesia vascular throbbing is occasionally noticeable, as may also be the transmitted effects of the wide diaphragmatic excursions to which this anæsthetic gives rise.

THE AIR BUBBLE

At the highest point of the bladder there is always a greater or less collection of air (*Plate I*, E, page 68) which has been driven into the bladder from the catheter during preparation. It forms a beautiful object, reflecting the rays of the lamp and trembling delicately with every motion of the contained fluid. It may be round or oval, single or multiple; multiple bubbles may be seen lying in apposition or may be separated from each other by a short intervening distance. A crescentic shadow is thrown on to the bladder wall by the bubble, and through the bubble can be dimly seen the vessels of the mucosa. The air bubble is a point of repair in the orientation of the bladder to which some cystoscopists attach considerable importance. Too large a bubble is objectionable, for its convex surface acts as a lens, and by this means and also by reflecting light it obscures the apex of the viscus. The size of the bubble should not represent more air than that contained in the catheter. Air introduced from the syringe indicates carelessness in preparation. The surgeon should take a pride in keeping the air bubble small.

CHAPTER V

CYSTITIS. SIMPLE ULCERATION

CYSTITIS

THIS condition may be dealt with as follows (I) *Simple cystitis general features,* (II) *Cystitis due to the Bacillus coli communis,* (III) *Gonorrhœal cystitis,* (IV) *Abacterial pyuria,* (V) *Rare forms of Cystitis*

I. SIMPLE CYSTITIS · GENERAL FEATURES

The term 'simple' is used to exclude the tuberculous and syphilitic varieties of cystitis, each of which will be described separately later Simple cystitis is of everyday occurrence in a urological practice, so that an intimate knowledge of its cystoscopic features is of great importance By its frequency, however, it presents repeated opportunities for study

Indications for and Contra-indications to Cystoscopy.—In acute cystitis it is usually unnecessary to employ the cystoscope, as the diagnosis can be made from the symptomatology A sudden onset of frequent and urgent micturition, with pyuria, and perhaps terminal hæmaturia and pyrexia in severe cases, is usually sufficiently characteristic As there is a definite danger of adversely influencing the course of the complaint by trauma to the inflamed mucosa or by introducing fresh flora into the bladder, it is generally wise to avoid cystoscopy On the other hand, chronic cystitis and many cases of subacute cystitis require cystoscopy in order to determine the reason for their failure to respond to treatment, and to ascertain whether there are any unsuspected complications in the bladder or kidney which are responsible for the protracted course of the disease.

Acute urethritis is an absolute contra-indication to cystoscopy, and in subacute urethritis it should be undertaken only after careful consideration Bladder symptoms arising in the course of acute posterior urethritis are very common, especially frequency of micturition and terminal hæmaturia It should be assumed that they are caused by the posterior urethritis, and in fact they almost invariably disappear as this subsides The lesion responsible for such symptoms is an œdema of the vesical outlet (*see* page 93)

Patients suffering from advanced renal deficiency in suppurative nephritis associated with cystitis should be investigated as far as is

possible, by other means before urethral instrumentation is undertaken because of the danger of expediting suppression of urine

Preparation of the Bladder—The preparation of the inflamed bladder has already been dealt with on page 53 Inflamed bladders, being hypersensitive, resent the interference that is necessary in preparation, which is unfortunate for they require a greater amount of lavage than does the normal organ owing to the difficulty experienced in getting them clear of pus etc They must be handled skilfully, for otherwise the cystoscopy will fail However they vary considerably in their tolerance of bladder washing and their behaviour can be only approximately surmised in advance Generally speaking if an inflamed viscus has had a free exit it will have emptied itself at short intervals and will be found contracted and difficult whilst one which has been obstructed, and especially one with residual urine, will be of good size and often actually dilated Such bladders are usually quite tolerant, even though inflamed and can be handled without restraint Occasionally, however they contract down immediately they are emptied and subsequently refuse to take more than a few ounces of fluid

If a small bladder is over distended before its limitations are realized much harm as evidenced by hæmorrhage and increased intolerance may be done and a satisfactory cystoscopy may be prevented Whenever therefore pyuria and a history of frequent micturition or tenesmus are met with the surgeon should assume that the bladder will be difficult to prepare until it is proved otherwise, and the precautions recommended below should be instituted *from the beginning* They are a resume of the method already more fully discussed elsewhere (page 53)

1 Good anæsthesia is essential (*see* page 38)
2 Note condition of catheter specimen as regards pus also quantity of urine present in the bladder
3 Inject 1 oz and no more
4 Successively increase by 1 oz stages until signs of restlessness or increased depth of the respirations become apparent These latter will show themselves even when the patient is under general anæsthesia but probably not under spinal anæsthesia Regard this as the maximum capacity of the bladder Do not utilize the whole available space again
5 Never completely evacuate the bladder Leave in 1 oz or so to accommodate the tip of the instrument
6 When filling the bladder for examination do not distend fully as further fluid contributed by the kidney must be accommodated
7 Be careful not to bruise the bladder wall by rough handling of the cystoscope for this will cause hæmorrhage and bruising of the vesical mucosa and will also be painful
8 Waste no time in commencing and carrying through the investigation once the bladder is ready for your opportunity may disappear

DATA REQUIRED —The cystoscopist will require information with regard to the following —

1 *The type* of the cystitis acute subacute or chronic, hæmorrhagic or gangrenous, whether decomposition of urea is occurring or not In many cases the organism may be surmised from the lesions present

2. *The anatomical distribution*—for instance, whether basal, cervical general, surrounding one ureter etc

3 *Site of origin*—ascending or descending etc

4 *Complicating lesions*

5 *Size and irritability of the bladder* Already observed during preparation

6 *Progress* Signs of extension or resolution, active ulceration, etc, less or more severe than at a previous cystoscopy The number of ounces of fluid which the bladder will tolerate is a valuable indicator.

7 *Prognosis* as judged by a review of all the factors

8 *Indications for treatment*

Aetiology.—The surgeon will attempt to locate the origin of the cystitis, though this is not always easy The most important varieties are bacterial in origin but frequently *mechanical chemical, and thermal irritation* will produce hyperæmia œdema, etc, of the mucosa Thus an injected membrane may be found as the result of contact with a urine of high concentration or otherwise abnormal in constitution or as a sequel to the use of a thermal or chemical irritant in the bladder lotion Similarly the region occupied by an aseptic stone may be hyperæmic œdematous or even ulcerated, whilst a median basal œdema may follow ungentle instrumentation

When the disease is of *bacterial* origin the primary focus of infection must be sought for It should first be ascertained whether any previous instrumentation may have infected the viscus Failing that, the primary focus must be either in the kidney (a descending infection, *see* page 365) or in the prostate and urethra (an ascending infection *see* page 281) Direct invasion of the bladder from the blood-stream is held to be rare Infection from an adjacent viscus e g the bowel or a seminal vesicle is occasionally observed and is usually preceded by some morbid process in that organ itself—for instance, appendicitis or diverticulitis or malignant disease which goes on to perforation

Cystitis may occur as an infection of a previously healthy bladder, or as a *complication* in a viscus which already contains some other pathological process In the latter case it can of course occur as an unconnected incident but it must be remembered that the majority of bladder diseases predispose to inflammatory mischief and that in many the organisms would never have obtained a foothold had not the resistance been lowered by some preceding disease. In conjunction

each lesion is adversely affected so that the cystitis itself is likely to be more severe and intractable In all cases but especially where the cystitis is of long standing or persists in spite of treatment the cystoscopist must be on the look out for complications Cystitis may of course be added to any bladder lesion whatsoever, so that a complete list of these would include every possible bladder disease The following however are the important ones and they are frequently encountered malformations especially diverticula (true and false) other inflammations especially tuberculous fistulæ parasites especially bilharziasis bladder stone and foreign bodies and neoplasms, simple and malignant The conditions which cause urinary retention constitute another group not primarily intravesical yet predisposing to cystitis, and they are recognizable during the cystoscopy or its preliminaries They are stricture prostatic hypertrophy, and diseases of the central nervous system in the male and in the female certain enlargements of the uterus, especially fibroids and carcinoma, and, again disease of the central nervous system Each of these will be considered in its appropriate place

The symptoms of cystitis may be simulated by —

a Any condition giving rise to excessive quantities of urine—glycosuria chronic nephritis hypertension etc

b Diseases of the neighbouring organs in the *male* urethritis and prostatitis in the *female* any inflammatory disease of the organs of generation (the commonest is cervicitis) or of their surroundings—parametritis, etc Also displacements and enlargements of the uterus (*see* Chapter XIX)

c Nervous conditions—excitement anxiety hysteria etc

All these possibilities should be kept constantly in mind in studying a case The absence of pus from the properly obtained bladder urine (*see* page 50) is important evidence (*See also* Appendix)

Cystoscopic Appearances of Cystitis

Cystitis offers an excellent opportunity to study the naked eye changes which a typical mucous membrane undergoes in inflammation Nowhere can these be more advantageously observed The appearances are, however slightly modified by two factors—namely the necessity of examining through a fluid medium and, under certain circumstances the presence on the membrane of the products of urinary decomposition We shall study the subject under the following headings (1) *Vascular changes* (2) *Changes in the mucosa*—desquamation œdema ulceration proliferation (3) *Inflammatory products observed on the bladder wall*—mucus epithelium pus blood membranes products of urinary decomposition (4) *Changes in the musculature*—alterations in the size of the bladder trabeculation and false diverticula

1. Vascular Changes.—Dilatation and increase in apparent size and number of the vascular systems is the earliest change observed All types of vessel enlarge Arterioles which normally are unrecognizable become apparent, vessels which were previously but twigs take on more important dimensions, whilst the parent trunks may become several times their previous girth The various systems therefore become larger, richer, and more complex, and in addition inosculation between them becomes freer and more evident The general tone of the bladder wall becomes redder and duller These changes are illustrated in *Plate III* A, which is taken from a case of mild cystitis When the dilatation is further advanced the vessels in some instances show a liability to rupture This mainly implicates the parent stem the hæmorrhage not uncommonly being seen where the trunk first emerges under the mucosa It usually remains submucous—a hæmatoma with its maximum concentration situated over the vessel and the

PLATE III

A, *Cystitis of medium severity* Note the hyperæmia, the laked appearance of vessels' edges, and the washy mucosa Mucosa appears puffy—purulent deposit B, *Severe cystitis* Redness of one portion very marked It rapidly fades into an area of much less severe inflammation Submucous hæmorrhages seen round stems of main vessels C, *Bullous œdema*, surrounding and hiding the ureteric orifice in a case of prostatic hypertrophy The red structure in the lower portion of the picture is the medium lobe Note that it can be seen in the same cystoscopic field as the site of the ureter (cf page 278) Compare these bullæ with those seen in *Plate IV* D and E D, *Cystitis cystica* Minute cysts, resembling dewdrops E, *Cystitis membranosum* Small portion of an extensive vesical membrane Evidences of cystitis in this plate much less marked than usual F, *Œdema trigoni pseudomembranosum* Right half of trigone with ureter Trigone covered with thin pellicle of proliferated epithelium, the margin of which is irregular, fairly sharply defined, and slightly elevated

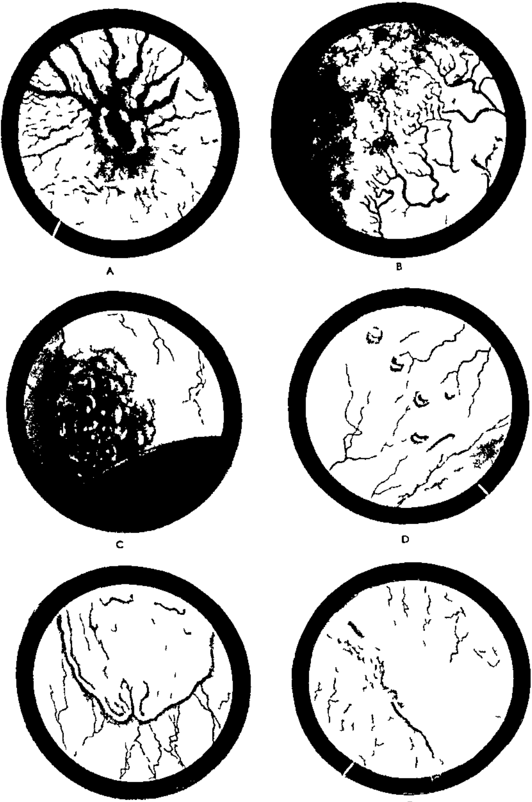
effusion diminishing in intensity towards its periphery, which exhibits the washed appearance seen in *Plate III* B The hæmorrhage may however, occur on the surface of the membrane (hæmorrhagic cystitis) This is particularly well seen in gonorrhœal cystitis

Severer stages in the inflammation show increasing vascular engorgement, until eventually the sandy colour of the vesical wall is completely replaced by vascularization The coloration at this stage resembles the rich venous hue seen in fine healthy granulation tissue and the general appearance is in many respects comparable thereto

When the cystitis is receding or becoming more chronic a brighter tinge is noticeable suggesting that venous stasis and engorgement are now playing a smaller role, and that the blood is more generously oxygenated However, regeneration of epithelium affording improved light reflection is partly responsible for this brighter appearance As the cystitis subsides the blood-vessels diminish in number and size until, if resolution is complete, the normal coloration is restored

Pl 171 III

SIMPLE CYSTITIS



Various parts of the same bladder frequently display different degrees of vascular engorgement, so that by moving from one to another the student may pass them in review successively. *Plate III* B depicts an area in which the transition from mild to intense hyperæmia is rapidly effected.

The changes above described are less apparent over the trigone, for the normal vascularity of this section is already great, and in many instances scarcely admits of increased redness. Inflammatory change in this region is evidenced by œdema and epithelial proliferation.

The colour of the mucosa can be altered by the presence of blood in the vesical medium and by other extraneous influences (*see* page 68).

2. Changes in the Mucosa.—

Desquamation.—Desquamation is one of the earliest phenomena of bladder inflammation, the shed squames being evident in large numbers when the urine is examined under the microscope. Epithelium does not exist at any period in sufficient quantity to be separately recognizable through the cystoscope, but it is most abundant in the earliest stages of acute cystitis, when in combination with a few leucocytes and a little mucus it constitutes the filmy pellicle then observable. It also occurs in large quantities in the urine in leucoplakia. In acute cystitis loss of the superficial layers is chiefly responsible for the dull and granular appearance of the mucosa.

At a certain stage in the recovery from acute cystitis, as also in some types of chronic cystitis, the bladder wall takes on abnormal brightness; sometimes it almost appears to be flecked with silver as a result of the excessive regeneration of epithelium. This stage of epithelization corresponds to the phase in which the vascular engorgement has partially subsided and the coloration of the mucosa has faded to a palish pink. Cystoscopy is now very easy, for light reflection is excellent, and all the walls are close to the prism owing to the small size of the cavity.

Epithelial proliferation is frequently observed over the trigone in cases where there has been long-standing irritation. It has received the name 'œdema trigoni pseudo-membranosum' (Pilcher). It occurs much more often in the female bladder than in that of the male. Its appearance is that of a colourless semi-transparent fluffy pellicle adherent to the trigone (*Plate III* F). Its surface and its borders are irregular, and the latter may be well defined or fade away into the normal mucosa. Sometimes the whole trigone is overlaid by the membrane, but usually it is more limited in extent. This condition may be found in bladders which otherwise show little or no sign of cystitis and where the urine is sterile. Frequently the patient complains of some degree of ardor urinæ. The trouble is often traceable

to some pathological condition of the neighbouring organs of generation such as a cervicitis or a uterine displacement, etc

Œdema of the Vesical Mucosa—Some exudation into the bladder mucosa invariably occurs in cystitis but it is not very obvious through the cystoscope until it is well marked In severe cystitis the swelling becomes very pronounced and the mucosa comes to look stiff and inflexible. This condition is best appreciated by observing the appearance of the muscular bundles The edge of the mucosa covering these structures, instead of being sharply cut, becomes swollen and rounded, and as the light catches its margin it displays the coarse and granular texture of the membrane The lesser muscular strands disappear altogether, only the larger bundles being able to show up through the thickened membrane

Œdematous thickening is very frequently observed around the *vesical neck* in females A minor degree of plication may almost be regarded as normal in this sex (*Plate I* D, page 68), but an œdematous exaggeration occurs during the vascular engorgement of pregnancy, at the catamenia and in other uterine and vesical affections The bladder neck appears to be elevated in longitudinal folds or pleats converging on the urethra, and when seen cystoscopically these are exaggerated by their close relationship to the prism They may be a cause of frequency or discomfort Examination of the bladder in a female complaining of urinary irritation should always include a search for them

Two varieties of œdema which may be, but are not necessarily, inflammatory phenomena are conveniently considered in the present chapter They are bullous œdema and cystitis cystica

BULLOUS ŒDEMA —This is one of the commonest conditions seen in the bladder (*Plates III* C, *IV* D and E page 122 *VI* D, page 152, *XII* F page 272 etc) Whilst it is as a rule, associated with some form of infection simple or specific, it may also be found apart therefrom—for instance where a stone rests on the bladder base, or surrounding a calculus impacted in the lowest segment of the ureter (*Plate XIII* C, page 338) It is seen around the base of a neoplasm, especially a malignant one (*Plate VIII* E, page 180) or near the site previously occupied by a simple papilloma following treatment with the high-frequency current (*Plate X* D, page 202), and in many other situations where asepsis obtains it is, in fact, a simple œdema occurring in a position where special anatomical conditions are present and producing distinctive features

The mucosa of the vesical wall is said to be bound down to its subjacent strata by a hexagonal reticulum. Therefore when swelling occurs under the mucosa it raises the membrane in the intervals between this honeycomb-like mesh and the resulting appearance is

that of closely lying dome shaped bullæ which appear to rest on the mucosa They are usually small and have delicate translucent walls which imprison a watery, straw coloured exudate When more tensely filled they lose the appearance of lying side by side and project as agglomerate masses of diaphanous rounded vesicles like a bunch of grapes or a hydatid mole (Marion and Heitz Boyer) This excessive development is, however uncommon Their superficial extent is as a rule limited Their position is regulated by that of the pathological lesion which has brought them into being so that they occur more frequently on the base though they may be found in any part of the viscus which has been subject to irritation Sometimes however they are seen in small clusters spread widely like a rash over the entire surface of the bladder, each group consisting of a limited number of vesicles resting on a dull hyperæmic base whilst the remainder of the mucosa is then also somewhat red This picture is most commonly seen in subacute or chronic *B coli* infections

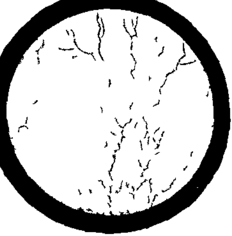


Fig 66 —Cysts of trigone

Cystitis Cystica (*Plate III* D) —Compared with bullous œdema this is rare In it minute cysts or vesicles occur scattered about on the bladder surface They may be single but are more often multiple They are not bunched together as in bullous œdema but remain isolated and often widely separated Sometimes they are seen as low lying dome like structures When more tensely filled they assume a hemispherical shape, whilst quite often perhaps characteristically they stand up from the bladder wall like minute balloons attached only by a delicate narrow pedicle There is no areola of hyperæmia Their contents are clear and colloid in consistency and the cysts are paler than the bullæ of bullous œdema though in older cysts the contents become darker Their appearance has been well likened to that of dewdrops lying on the bladder mucosa and they are principally found on and around the trigone (*Fig* 66) and bladder neck

As long ago as 1893 Brunn described plugs of epithelial cells which push their way down towards the submucous layers of the bladder These are now known as Brunn's nests' In time a drop of fluid appears in the centre of the plug Two separate and distinct lines of development are now possible In the first the fluid *increases*

in quantity and forms a cyst which in due course projects into the bladder—'cystitis cystica'—the innermost layer of cells becoming compressed and flattened The second possibility is that the cells surrounding the original globule of fluid arrange themselves into two or three layers disposed radially around it A communication is then established with the bladder cavity so that newly formed crypt-like glands drain into that viscus The inner lining of these glands consists of columnar epithelium with basal nuclei, and mucus in the more superficial parts (Storck and Zuckerkandl) True mucus is actually shed into the bladder The condition is now called 'cystitis glandularis' Cystoscopically cystitis glandularis is not easily recognizable, but it is often associated with cystitis cystica Stirling and Ash say that it presents irregular mammilated elevations confined chiefly to the neck and trigone of the bladder Hinman and Cordonnier call the appearance papular

The resemblance to the goblet cells of the rectum is close and, as portions of the bladder are actually derived from the hindgut, the temptation to attribute their presence to embryonic rests as has been done by Lecene and Hovelacque and by François, is obvious. Patch, who has studied the condition closely, has, however, traced the various stages of evolution from the Brunn's nests to the stage of cystitis glandularis and is satisfied that the latter condition arises as a metaplasia of the bladder epithelium It is from these newly formed glands that one variety of adenocarcinoma of the bladder is thought to arise (*See* page 195)

Cystitis cystica and cystitis glandularis appear to be due to prolonged irritation and are found associated with a variety of lesions of which stone and chronic infection are the commonest, but they have also been found in the obstructed bladder even when uninfected The exstrophic bladder has proved itself a good source of material for studying the development of these two conditions (Scholl) In cystitis cystica the irritation must be of limited severity otherwise the superficial bladder epithelium would be destroyed and shed and with it the cysts would disappear (Herxheimer) Similar lesions have been observed in the ureter and renal pelvis (Morse, Paschkis, et al) ureteritis and pyelitis—cystica and glandularis They too are referable to mild irritation from stones infection, etc Patch points out that, as the forerunner of the pelvis and ureter is the Wolffian duct, it is evident that here at least the lesions cannot be referred to the hindgut A few instances have been recorded in which cysts have caused air-bubble-like filling defects in the pyelo-ureterogram and the combination of cysts in the bladder with a filling defect has led to an accurate diagnosis on several occasions The cysts as such do not call for treatment; any treatment should be directed to the underlying cause.

Ulceration.—The subject of simple ulceration will be discussed at the end of this chapter (page 93)

Proliferative Changes.—When the bladder has been subject to severe inflammatory processes especially if they have been of long duration hypertrophic alterations in its mucosa are frequently observed They vary widely in extent distribution, and appearance Generally they affect restricted areas only and appear as small fleshy elevations on the mucosa not unlike exuberant granulation tissue (*Plate IV* F page 122) Sometimes they are more extensive, and assume various shapes which may be aptly referred to as vermicular, cerebriform or polypoid Perhaps the last title best describes the most common of these major hypertrophic lesions They consist of inflammatory buttons rarely larger than a pea and rounded or club shaped They are fairly frequently found around fistula (*Plate VI* D page 152), in severe tuberculous cystitis especially when secondarily contaminated (*Plate IV* F page 122) and around malignant neoplasms especially when infected In the latter it may be difficult to form an opinion as to how much is true neoplasm and how much inflammatory polyp They are also seen in chronic gonorrhœal and in syphilitic cystitis each of which is rare As a rule little difficulty will be experienced in distinguishing them from true neoplasms but if their nature is in doubt, they can be snipped off with the cystoscopic rongeur for microscopical examination Occasionally however it may be very difficult to establish the nature of a tumour when of a size greater than that just described especially when as often occurs it is buried under phosphatic debris and incrustations or occupies a hæmorrhagic bladder A course of vesical irrigation with silver nitrate of increasing strength continued over a number of days will probably succeed in cleansing the surface sufficiently to allow of a satisfactory inspection If of inflammatory origin they may disappear under this treatment

Leucoplakia.—Thickening and proliferation of the epithelium assume their most pronounced phase in leucoplakia to which a separate section is devoted in Chapter XVI (page 250)

3 Inflammatory Products observed on the Bladder Wall.—No secretion of any kind is observable on a healthy vesical mucosa Any visible deposit must therefore be pathological Such a deposit may consist of (*a*) Mucus (*b*) Epithelium (*c*) Pus (*d*) Blood (*e*) Membranes (*f*) Products of urinary decomposition

a Mucus.—This is a usual result of hyperæmia or irritation in any mucous membrane In urinary disease its presence is demonstrable in the flocculent deposit which settles at the bottom of a specimen glass Unless it is rendered opaque by admixture with pus it is usually invisible in the bladder Sometimes however a thick glistening

streak adherent to the walls may be observed. bearing a resemblance to a snail track. The existence of mucus is evident. however. when it is mixed with pus for it entangles the latter and twists it into bands or whorls which cling to the vesical floor and parietes

The ' mucous ' membrane of the bladder is a transitional epithelium and does not possess mucin-secreting glands. The so-called mucus found in the bladder is a pseudo-mucin formed from degenerating leucocytes and consisting mainly of nucleoproteins In the condition of cystitis glandularis (described on page 84) true mucus-secreting glands are formed and these pathological structures are the producers of the only true mucus obtainable from the bladder mucosa.

b Epithelium.—*See* page 81.

c Pus.—A certain quantity of white blood-cells is found in healthy urine passed from a completely healthy urinary tract. If limited in number the white blood-cells are to be regarded as physiological and should then be called leucocytes. but when exceeding that number they must be looked upon as a response to some stimulus traumatic or pathological They are then pus cells and the condition is pyuria The point of transition from the normal to the pathological is a matter of some interest and importance and has been variously estimated by different writers. The following figures are taken from an article by Moore :—

Hepler		8	cells per high-power microscopic field
Eisendrath and Rolnick		5–7	" " " " "
Moore	less than	4	" " " " "
Helmholz	males	2–3	" " low- " " "
	females	8	" " " " " "
Dukes		10	" " cubic millimetre

When pus is seen in the bladder it has the same characters as elsewhere. being a creamy or yellowish. opaque. and somewhat viscid liquid When mixed with mucus. blood. phosphates. epithelium etc however it assumes a variety of modified appearances Pure pus is usually completely and easily removed from the bladder and therefore when the preparation has been efficient none should be seen on cystoscopy It may be seen however. even after efficient bladder preparation if it has its origin in the kidney. for it then fouls the bladder again almost as soon as the latter has been cleansed Fluid pus of renal origin generally remains for a time in suspension in the vesical medium. rendering it murky. but if more solid it quickly sinks to the base whilst if very thick and inspissated and coming from a destroyed kidney. it emerges slowly from the ureteric orifice in a worm-like stream (*Plate XIV* B page 368) and never leaves the floor of the viscus Pus seen on the vesical floor shortly after satisfactory lavage has been obtained. or a medium which becomes

more pus and less epithelium. These membranes are coarser and more opaque in texture, and when containing quantities of fibrinous material they form tough, curdled masses, which may be firmly adherent, and which it may be impossible to dislodge by irrigation. The best developed membranes are found in old-standing and severe examples of cystitis where an admixture of organisms is to be found They are most firmly adherent when they overlie patches of ulceration or when occurring in a trabeculated bladder

iii The most marked adherent and fibrinous varieties are sometimes referred to as 'diphtheroid' Streptococci are usually responsible.

iv For œdema trigoni pseudo-membranosum, *see* page 81

f Products of Urinary Decomposition —When the urine is ammoniacal and stinking, quantities of phosphatic debris are very commonly seen entangled in the meshes of masses of muco-pus that occupy the base of an infected bladder, as also in membranes such as have just been described

Pathology of Phosphatic Deposits —It may not be amiss to recall a few facts concerning the deposition of triple phosphates from the urine There are three organisms which commonly infect the bladder, but which do not possess the power to split urea. They are the tubercle bacillus, the gonococcus, and the *B. coli*, and each of these lives by preference in an acid urine Most other organisms possess in greater or less degree the ability to split urea and this sets a train of consequences in motion the importance of which cannot be exaggerated and which completely changes the cystoscopic appearances, as indeed it alters the whole clinical aspect of the case

The chemical formula of urea is $CO\begin{cases}NH_2\\NH_2\end{cases}$ and when bacteriologically decomposed it acquires water and is split into NH_4OH and H_2CO_3 In this way the reaction of the urine becomes alkaline, and the offensive ammoniacal odour is produced which is characteristic of decomposing urine This reaction is very favourable to the growth of the majority of organisms, so that if unchecked the cystitis becomes increasingly severe, but, what is more important from our point of view, it causes precipitation of phosphates These are triple phosphates and are well known as contributing to the creamy or yellowish granular precipitate deposited from septic urine on standing Seen in the bladder they have the same appearance, but are generally intimately mixed with pus or muco-pus, or are entangled in the recently described membranes adding materially to their bulk and the coarseness of their texture When these masses are large and adherent they may easily be mistaken for phosphatic calculi, especially as the conditions render cystoscopy difficult They may adhere intimately to the bladder wall itself, giving it a white encrusted coat

(encrusted cystitis) but they cling particularly to the surface of simple or malignant ulcers and to a less extent to other pathological lesions. The underlying lesion in such circumstances is hidden and a course of bladder lavage may be necessary before the diagnosis can be completed. Finally, these phosphates may cohere and form a secondary (phosphatic) calculus. Such a result is more probable in the presence of residual urine.

From what has been said above it will be realized that phosphatic deposits and secondary calculi are not found in cases of uncomplicated infection by any of the three organisms mentioned previously—namely the *B. coli*, the gonococcus or the tubercle bacillus. It is further a practical observation that with these three organisms membrane formation is never well marked, though of course in the tuberculous bladder a certain amount is associated with the ulceration present. Each of them has distinctive characteristics which will later be separately described. In each the nature of the disease can usually be surmised from the cystoscopic examination, or at any rate they can be differentiated as a group from the urea-splitting varieties by the reaction of the urine and the bladder appearances. When, however, secondary organisms are introduced the cystitis takes on the attributes of the latter, and the original invader is eclipsed both cystoscopically and bacteriologically. Further, the inflammation enters a severer phase. This is least marked with the *B. coli communis* and most pronounced with the tubercle bacillus, where the addition of secondary infection marks an increase in the strangury and more continuous distress. As secondary organisms are only too easily carried on the end of an instrument from the urethra into the bladder, the surgeon will realize that in all such cases instrumentation—cystoscopic or otherwise—must be definitely indicated and punctiliously executed.

4. **Changes in the Musculature.**—

Alterations in Size of the Bladder.—The size of the bladder is usually diminished. In mild cases, even in the acute stage, however, it will occasionally hold 8 oz., but when the disease is severe it will be reduced and may not tolerate more than an ounce or two. Cystoscopy can be carried out in 2 oz. or thereabouts if the bladder is skilfully and gently handled, but this is a minimum below which the examination becomes valueless. The diminution is produced far more by the depth of the inflammatory process than by its superficial extent. This is well illustrated in the tuberculous bladder, where a single inflammatory area surrounding a ureter and containing one deep ulcer will cause much more contraction than does a superficial inflammation of the whole of the organ, say by the *B. coli*. In this shrinkage the trigone participates to a less degree than the rest

of the organ, and on inspection its reduction may not be at all evident When cystitis supervenes in a case of retention the bladder is prevented from contracting, and, indeed, may be much larger than the normal viscus In such circumstances it may be compared with a tuberculous joint which from the first has been kept in good position and in which muscular contraction has never been allowed to occur or to cause deformity

The mucosa generally appears to shrink *pari passu* with the musculature so that its surface does not become pleated or wrinkled to allow of its accommodation in the reduced organ Pleating is, however sometimes observed, and a good example occurring in a tuberculous bladder is pictured in *Plate IV* C, page 122 This appearance has been styled 'cerebriform

Thickening of the mucosa as a rule hides from view the musculature of the bladder, but when hypertrophy and trabeculation are marked, as in obstruction, it may be very conspicuous Again, where only a small area of the mucosa is inflamed the muscle bands underlying the healthy part may be observed to be in spasm, and their appearance suggests trabeculation

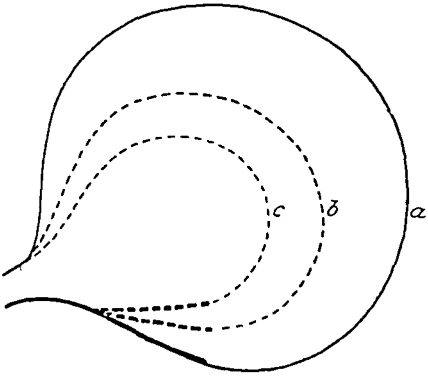


Fig 67 —*a*, Normal size of the bladder *b* and *c*, successive stages of reduction in size of bladder cavity The trigone is little or not at all altered in extent, but its posterior portion is elevated, or appears so through the cystoscope The roof is more accessible to inspection The anterior wall no longer rises sharply from the internal meatus but passes upwards and backwards to enter into the formation of the dome Cf method of contraction of normal bladder (*Fig* 63, page 67)

Effect of Contraction of the Bladder on Cystoscopy—*Fig* 67 indicates the alteration in shape which occurs in the bladder as its radii diminish The trigone is affected less than the remainder of the viscus so that at cystoscopy the ureters and interureteric bar seem to lie farther back than usual They also give the impression of being higher up towards the fundus owing to the elevation of the posterior portion of the trigone The anterior wall approaches the horizontal, and, together with the lateral walls, comes closer to the beak of the cystoscope Other things being equal, this should result in greater concentration of light and magnification Generally, however these advantages are more than neutralized by the altered conditions of the mucosa and the vesical medium the resultant being that visibility is impaired, but in favourable circumstances especially where the upper segment is healthy an improved view is obtained Whenever the bladder cavity is reduced the importance of keeping the air bubble as small as possible is greatly

enhanced a large bubble in a small bladder may obscure and distort the whole vault

Trabeculation and Diverticula—*See* Chapter X

Acute, Subacute, and Chronic Cystitis

It is not proposed to describe separately the cystoscopic changes observed in acute subacute and chronic cystitis These can to a sufficient extent, be surmised from the foregoing description, and in any given instance the patient's history and progress will assist in correct classification The cystoscopic features indeed, though generally reliable are not an infallible guide to the category in which any given example should be included Thus many protracted and resistant cases which from their behaviour should be ranked as chronic exhibit extreme degrees of hyperæmia œdema and other inflammatory changes simulating acute cystitis These subjects not infrequently show less evidence of discomfort than the intravesical appearances would portend On the other hand cases in which the history is recent the onset sudden and the vesical distress severe may show vesical lesions which are insignificant in comparison with the symptoms, and might, if judged by the cystoscopic appearances alone be ranked as subacute As similar pictures therefore may be found in dissimilar types of the disease it is better to avoid particularization of the individual traits of acute subacute and chronic cystitis and in placing a case in its correct class to rely on a general survey of its combined clinical and cystoscopic features rather than to depend on the latter alone

II CYSTITIS DUE TO THE BACILLUS COLI COMMUNIS

This is a distinctive urinary disease running a characteristic course and recognizable in most instances without cystoscopy The following brief outline of its main features in the acute phase is inserted to assist in the recognition of the disease apart from cystoscopy as that examination is best avoided (*see* page 76)

The onset is commonly acute and there may be fever Occasionally this is preceded by some derangement of the alimentary canal which is often slight and probably unassociated in the patient's mind with his urinary trouble until it is inquired about by the surgeon Following the febrile onset frequent and urgent micturition and strangury make their appearance and according to the severity of the attack there may or may not be terminal hæmaturia loin pain and tenderness and continuation of the fever The patient presents the usual febrile syndrome furred tongue anorexia, constipation etc Examination of the *urine* will show pus Coming it first from the kidney it sinks to the bottom of the specimen glass as a yellowish

creamy deposit It is slightly viscid in consistency and moves but sluggishly when the glass is tilted When the bladder becomes involved in the inflammatory process, mucus is found in the urine so that the deposit becomes billowy and flocculent The urine has a peculiar smell which has been likened to that of stale fish In the absence of alkalinization by drugs, it is acid Coliform bacilli are found with the microscope, and on culture a pure growth of the bacillus is obtained

When the case presents such or similar features a hæmatogenous infection of the urinary tract with the *B coli communis* may be confidently diagnosed. Does cystoscopy advance the diagnosis or do more than corroborate what is already known? My practice is to avoid it in such circumstances as little or no assistance in diagnosis and no indications for treatment are to be obtained by it, and no complications calling for modification of the prognosis or line of action are likely to be found, at any rate in the early stages with which we are at present concerned Occasionally, however, it is necessary to investigate such a bladder, and the appearance presented is that of acute generalized cystitis The cystoscopic changes vary with the acuteness of the infection, but are usually slighter than the bladder symptoms would lead one to expect Apparently the accompanying pyelonephritis and ureteritis augment the vesical irritability The most severe grades of hyperæmia are rarely seen, and the various arterial twig systems do not lose their identity, or become lost in a diffusely reddened bladder wall

The pus, being finely particulate and easily washed away, is generally completely removed in the bladder preparation, and as that from the kidney is insufficient to soil the organ again quickly there is little or no pus observed in the bladder In any case no large adherent mucopurulent sloughs are seen, nor, as the *B coli communis* does not split urea, is any phosphatic deposit found Ureteric meatoscopy is undertaken to confirm the renal origin of the disease and to decide which kidney is involved (*see* page 324)

When the cystitis is not of renal origin there will, of course, be no meatal change other than that common to the whole of the mucosa Occasionally concentration of œdema over the prostate and round the urethral opening may indicate the mode of access of the organism to the bladder, though this is by no means constant, and its absence does not exclude ascending infection

Chronic Cystitis.—Chronic cystitis due to the *B coli* is very common Here again the changes are less marked than would be anticipated from the vesical symptoms Various degrees of vascular dilatation and swelling of the mucosa are found, and occasionally widespread bullous œdema is seen (*see* page 83) When the disease is

of renal origin the ureteric manifestations may be slight but at other times the ureter has a dull red colour or shows evidences of chronic induration and perhaps epithelial proliferation (*Plate XII C* page 368)

III GONORRHOEAL CYSTITIS

With the modern antibiotic treatment of urethritis gonorrhoeal cystitis always rare will probably entirely disappear Acute and subacute urethritis interdict cystoscopy and for this reason the bladder usually escapes exploration when symptoms of cystitis supervene in the course of an attack of gonorrhoea Discretion should be exercised in making the diagnosis of cystitis during the course of this disease, for posterior urethritis often produces symptoms which closely mimic those of cystitis—namely, frequent and urgent micturition, and occasionally terminal haematuria and febrile disturbance It should be remembered that the bladder is very resistant to the incursion of the gonococcus and is involved in only a small proportion of cases The fact that it tolerates treatment by 'grand lavage' is evidence of its resistance as many gonococci must thereby be washed into its cavity Three types of cystitis occurring in this disease require description (1) Cystitis due to the gonococcus itself (2) Cystitis due to secondary organisms which have contaminated the original urethral infection and (3) Cystitis that is the consequence of late complications such as stricture chronic prostatitis and so on

Of these groups the second may be an acute, a subacute, or a chronic process but generally tends to resolution It has no special features The third group will be found dealt with in the appropriate sections Cystitis due to the *gonococcus itself* may take one of several forms and may be classified as (1) *Acute* (2) *Chronic*

1 **Acute**—Of the acute form the following varieties may be described (*a*) Cystitis of the neck (*b*) Cystitis of the body—acute hyperacute

a Cystitis of the Neck (*Cystitis Colli Gonorrhoica*)—This occurs during the stage of acute posterior urethritis and should be regarded as an area of vascular engorgement abutting on that acute process It is not a true infective cystitis To the cystoscope the cervical mucosa appears to be thrown into folds It may be intensely congested and bleed freely as the result of instrumentation The remainder of the bladder is healthy or perhaps slightly hyperaemic owing to the neighbouring irritation

b Cystitis of the Body (*Cystitis Corporis Gonorrhoica*)—This is much less common It is peculiar in that it involves isolated islands of the vesical wall leaving intervening areas of healthy mucosa

The bladder is therefore marbled or mottled with zones of cystitis, and these tend to affect the roof rather than the base Both these facts distinguish it from other forms of cystitis. The affected areas show a strong disposition to bleed (hæmorrhagic cystitis)

The *hyperacute* variety is most commonly seen in the course of the subacute or chronic phase of the urethritis, and neglected and untreated cases are the most often attacked The urethral infection is liable to be masked and overlooked owing to the vesical pus and strangury, so that the diagnosis may first be made with the cystoscope The disease runs a severe course and may terminate fatally as the result of renal infection The essential features correspond to those of the last described variety The isolated areas have, however, become confluent, and the whole bladder is affected, though the disease predominates in the upper zone The bladder capacity is signally diminished, 3 oz or less being all that it will tolerate, and any attempt to increase the distension immediately excites hæmorrhage The tendency to bleed is pronounced, and numerous ecchymotic spots may generally be observed on the parietes and especially on the roof Adherent sloughs and precipitation of phosphates are little marked, as the cystitis occurs with an acid urine The ureters are easily identified in spite of the intense engorgement and swelling and the decrease in bladder capacity

This variety of gonorrhœal cystitis simulates the late stages of the tuberculous bladder more closely than does any other type of cystitis, its small size, intense irritability, and proneness to bleed, together with the large amount of pus contained in an acid urine, all suggest a tuberculous origin, but the cystoscopic findings—namely, the absence of ulceration, the implication of the roof rather than the base, the ease with which the ureters are discovered, the results of ureteric catheterization and renal function tests—combined with the failure to find the tubercle bacillus or the discovery of the gonococcus, serve to distinguish the two

2. Chronic.—Chronic gonococcal cystitis is a milder variant of the conditions above described, the mosaic-like appearance still persisting Marion and Heitz-Boyer state that this form often produces polypoid granulations, the occurrence of which is but little known They exist as mushroom-shaped elevations, with smooth, rounded, club-shaped summits and a pedicle which is almost as large as the summit Their colour is brownish or violet, and therefore darker than that of true polypi The combination of a polypoid mass and hæmorrhage will naturally suggest a neoplasm, but one should be put on one's guard by the multiplicity and the apical situation of the lesions, and by their deeper colour, whilst the beneficial effects of vesical lavage with silver nitrate will substantiate the diagnosis

IV ABACTERIAL PYURIA

White blood cells escape into the urine in certain diseased states of the tract even when infection can be ruled out. Amongst other causes new growths, stones and nephritis may be mentioned. Again in the dying out stages of a known bacterial infection it may be difficult or impossible to demonstrate the organisms and this is true also in some cases when the microbe is controlled by antiseptics or bacteriostatics. When organisms are not discoverable in a case of pyuria tuberculosis springs early to the mind.

When these various possible causes of a sterile pyuria have been eliminated there remains a group of cases to which the name 'true infective abacterial pyuria' has been given by Thomas Moore. This group appears to constitute a specific clinical entity. Many of the patients are male adults but females are not immune. The third, fourth and fifth decades are especially liable to the disease. The complaint is of urinary frequency and pain, dysuria and hæmaturia, and these symptoms become very severe. The bladder at cystoscopy presents most of the characteristics of a severe cystitis—hyperæmia, ecchymoses and occasionally ulceration etc. It becomes contracted and intolerant. In fact the symptoms much resemble those of urinary tuberculosis for which it has many times been mistaken and the resemblance is accentuated by the absence of demonstrable organisms. The cystoscopic picture however distinguishes between the two diseases. The inflammation may be confined to the lower urinary tract, bladder and perhaps prostate, but in other cases catheterization of the ureters will discover pus cells in the collected urine and in some cases where nephrectomy has been done on the assumption that the condition was tuberculous the pelves and ureters have been found inflamed and swollen. Intravenous pyelograms may show ureteric dilatation.

The disease is quite uninfluenced by the usual urinary antiseptics but yields almost immediately to neoarsphenamine (0 2 to 0 3 g being given weekly for four weeks) N A B or other arsenicals which appear to act specifically.

The cause of the disease is unknown though it may ultimately prove to be due to a filter passing virus. The fact that other viruses are uninfluenced by the arsenicals seems to be a point against this view. The prognosis is good owing to the spectacular response to the arsenicals.

V RARE FORMS OF CYSTITIS

Cystitis Follicularis is a rare bladder lesion. Lymph follicles lying close beneath the epithelium are responsible for 'discrete nodules of varying size particularly over the trigone and base

3. Simple Cystitis.—Ulceration is rarely produced by simple cystitis if the desquamation described on page 81 is excluded. Occasionally, however, in *B. coli* infection of the bladder a round or oval ulcer of small size is observed, having a slightly excavated base and margins which are undermined. It is usually single, but may be multiple. Ulceration occurs also in typhoid fever, the lesions having characters similar to those seen in the intestine.

4. Solitary Ulcer.—This was first described by Fenwick (1896). It is very rarely seen. Its site of election is the trigone, though it has been observed further back. It is generally deep and crater-like and its base is covered with a slough. Its margins are raised, clean-cut, or undermined, and it is surrounded by a hyperæmic areola. Its evolution is slow. Fenwick in his classical description recognized three stages in its evolution. (*a*) The simple ulcer, the remainder of the bladder being healthy, (*b*) Ulceration associated with cystitis and incrustation, (*c*) Infiltration of the muscular coat with vesical contraction. Occasionally a contact ulcer forms on the opposing wall of the bladder. Fenwick regarded the condition as amenable to appropriate treatment.

Ulcers having characteristics similar to those described above were not uncommonly seen in the old days prior to the introduction of the modern cold cystoscopic lamp, and owed their existence to the burns produced on the mucosa by its predecessor, the hot carbon filament lamp.

5. 'Hunner's Ulcer' (Synonyms—'cystitis parenchymatosa' (Nitze), 'panmural cystitis' (Stevens), 'submucous fibrosis').—This is an important, though not very common condition and appears to be a definite pathological entity to which perhaps sufficient attention is not paid in this country. It was well known to Nitze, whose admirable description of it embodied most of the facts available even at the present day regarding its cystoscopic and microscopical appearances and its symptomatology (*Lehrbuch der Kystoskopie*, 2nd edition, p. 207). The disease was re-described by Hunner in 1914, and is most often referred to by his name. Paschkis regards this and Fenwick's ulcer as quite different conditions.

The distinctive lesion is an inflammatory focus which develops in the middle layers of the bladder wall and appears to have its beginnings in the submucous coat. Papin says that it is a special affection of unknown pathology, which is neither tuberculous, specific nor neoplastic and which cannot be accounted for either by traumatism or lesions of the central nervous system. The microscopic features are those of any small area of inflammation, there being vascular engorgement, thickening of the basement membrane, and

round celled infiltration the latter being as a rule, particularly in evidence As the focus enlarges it extends on the one hand to the muscular coats, and it may involve the perivesical tissues, even giving rise to a perforation which has been known to implicate the pelvic cellular tissues or peritoneal cavity Advancing towards the bladder cavity on the other hand the inflammatory area affects the mucosa and produces a central ulcer Ulceration is therefore a secondary phenomenon According to the size of the inflammatory focus, it will be seen that it may remain localized to the submucous area or involve any part or the whole thickness of the bladder

Two theories are advanced to account for this pathological entity —

a That it represents an unhealed remainder left after an attack of acute cystitis The facts however that few of the subjects give a history of acute cystitis and that the usual onset is insidious appear to belie this view a view that regards the mucosal inflammation as primary and the submucosal condition which is the peculiar feature of the disease as secondary and residual

b Some evidence exists to support the hypothesis that the foci are caused by blood borne organisms though here again the proof is lacking Septic foci in the urethra teeth tonsils nose gall bladder etc, have been alleged as absorption grounds and attention directed to the cure of these has appeared to react favourably on the bladder lesion, sometimes indeed a relapse of the primary lesion has been followed by recrudescence of bladder symptoms Meisser and Bumpus have grown organisms from the teeth and tonsils of affected patients and have experienced some success in reproducing similar bladder lesions in the lower animals Streptococci are apparently the offending pathogenic organisms This theory of blood borne infection of the deep bladder structures enjoys a good measure of support at the present time It appears especially likely that urethral sepsis is a site from which absorption may arise A granular urethritis is frequently associated

Cystoscopic Appearances—The ulcer is usually though not invariably single and its site of election is the vesical dome But few have been observed in the periureteric area and none so far as the writer knows on the trigone itself The margins of the actual ulcer are ill defined and merge insensibly into the surrounding redness and œdema A few ragged sloughs may be seen on or near the ulcer The whole area of involved bladder will appear no larger than a threepenny piece but if operated on excision of such an area will not relieve the patient's symptoms The bladder capacity is severely reduced and the organ may refuse anything above 2 oz of lotion Attempts to exceed this acquired maximum cause intense pain and are

very liable to give rise to bleeding. Nitze, employing an irrigating cystoscope, gently over-distended the bladder whilst the ulcer was under inspection and actually watched the surface of the ulcer tear and start to bleed, an observation which accords well with the patients' statements that if they attempt to retain urine too long they suffer from hæmaturia. This experiment has since then been repeated on many occasions by myself and others and I have touched such an ulcer with a ureteric catheter and have noted how readily it bled.

The remaining portions of the bladder may be perfectly healthy, and this, in fact, constitutes the customary picture. There is then little or no sediment in the urine, and the microscope reveals only a few erythrocytes, an odd leucocyte, and no organisms. In such patients the slightness of the deposit in the urine is in striking contrast with the severity of the patients' discomfort (Nitze).

In other cases, however, the whole of the bladder is inflamed, and this has the important disadvantage that it masks the actual ulcer. Perhaps that was why Hunner christened them 'elusive ulcers', a term which has had some vogue. The more important part of the cystoscopic picture is therefore overlooked, and doubtless many such cases are labelled as simple cystitis. The urine in such events contains a deposit resulting from the cystitis, but the severity of the symptoms should proclaim a lesion more grave than a simple cystitis.

Almost all patients are between the ages of 25 and 55, and females preponderate—about 5 women to 1 man. The onset is insidious and at first there are intermissions, but eventually the symptoms become severe. Micturition is increased in frequency to so great a degree that the case forcibly recalls one of urinary tuberculosis, the bladder incessantly demanding to be emptied day and night. It admirably illustrates the distressing effect of bladder ulceration on capacity (*see* page 40). Suprapubic and urethral pain are marked and hæmaturia is often observed. The menstrual flow causes an exacerbation in the severity of all symptoms.

Treatment.—Hunner lays emphasis on the localization and eradication of any possible source of absorption as the first step in the treatment of this disease. In practice it rarely proves sufficient, and firm distension of the bladder under spinal anæsthesia is the next procedure to be tried. Sometimes it succeeds and it may be repeated if necessary. This failing, resort must be had to destruction of the ulcer either by excision or by fulguration. The former has been the practice of many surgeons in the recent past, but it is at present somewhat under a cloud as there have been some deaths and many recurrences (up to 50 per cent—Gilbert Smith). It is simplified in some measure because the ulcer usually occupies the bladder vault,

but on the other hand the shrunken size of the viscus and the large extent of wall involved—always greater than that suggested at cystoscopy—actually render the operation one of considerable difficulty. Hunner attributes recurrences after excision to incomplete removal of the affected area, but Furness remarks on the difficulty of seeing the extent of the ulcer at operation and the consequent danger of leaving affected bladder wall behind.

In America, where these ulcers appear to be much commoner than they are in England or on the Continent, the modern tendency is towards treatment by perurethral fulguration in the first instance. Recurrences are also common with this line of action, but the burning can be repeated. Gilbert Smith states that "with each recurrence the number of treatments required to give relief becomes less." Fulguration should not go deep as the bladder wall is thinner than usual and there is some danger of perforation. Also deep fulguration is said to be unnecessary and may produce massive scarring. Most surgeons now reserve resection for those cases in which fulguration fails. Whatever the treatment, there appears to be a strong disposition to recurrence.

CHAPTER VI

INTERLUDE ON THE PATHOLOGY OF RENAL TUBERCULOSIS *

NOT many years ago it was frequently reiterated in the surgical literature on renal tuberculosis that no solitary instance could be produced in which a tuberculous focus in the kidney had healed At a later time evidence that tuberculous lesions of the kidney can and do heal started to accumulate and an altered attitude to the pathology of this disease gradually made itself evident Research had been progressing from three standpoints—the post-mortem the clinical, and the animal experimental This work will be briefly reviewed A prominent position must be allotted to the work of Medlar, who was a pioneer in the field and who has made important contributions to the investigation of post-mortem material and also to the experimental aspect

Post-mortem Investigations.—Medlar ran serial sections from the kidneys of 30 patients dying from pulmonary tuberculosis In the 100,000 sections which were studied 367 definite tuberculous lesions were found Their distribution was as follows in the cortex (75 per cent), medulla (11 per cent) and cortico-medullary areas (13 per cent) Scattered through the kidneys were also many *scars* which appeared to result from the healing of tuberculous foci Sometimes (14 subjects) scars and active tuberculous lesions appeared simultaneously at others (6 patients) scars were present without active tuberculous foci, whilst in 8 patients tuberculous lesions were present but no scars It became desirable to trace the genesis of these small cicatrices which unfortunately offer no peculiarity whereby their origin can be recognized Medlar, having been at pains to exclude scars of other origin (atheroma, infarction, etc) and having rejected

* The inclusion of a section on the pathology of renal tuberculosis in a work on Cystoscopy and Pyelography may, at first sight, appear curious and perhaps calls for some explanation This is a disease which, to the inquiring mind, presents a number of knotty problems regarding its mode of infection, course and behaviour, problems which one cannot start to solve in the absence of an adequate knowledge of the relevant pathology The solution of these problems gives the urologist deeper insight into the meaning of his cystoscopic and pyelographic pictures and must strongly influence his attitude to prognosis and the indications for treatment, which are largely based on those findings Thus the discussion is not out of place here It may also deepen some readers' interest in a fascinating subject

all kidneys in which evidences of concomitant disease were found showed that the *regional* distribution of these scars was proportionately identical with that of the active tuberculosis which he had found in the kidneys. Moreover these scars were many times more numerous than similar scars found in *non* tuberculous subjects. He concluded that the majority represented healed tuberculous foci. In the same organs tuberculous *lesions* of great variety and of varying age were to be found side by side suggesting that showers of tubercle bacilli had descended upon the kidney at different times. Some of these were actually in the process of healing whilst others showed no signs of doing so and might conceivably have gone on to the production of the so called surgical tuberculous kidney. In none of these cases had the renal infection been suspected during life and practically all lesions were so small as to be invisible to the naked eye and so would have escaped observation apart from any such painstaking search.

In 1923 an investigation on similar lines was carried out by Hobbs of the City of London Hospital for Diseases of the Chest. In 1000 necropsies he found macroscopic evidence of tuberculous disease in 16.2 per cent and in a smaller number of cases which he examined microscopically there were evidences of the disease in 32 per cent.

Clinical Investigations.—Pathological material which comes from the post mortem room is open to the usual criticism that it is obtained from patients with advanced disease and may therefore, give a false picture though the presence of healed and healing lesions can scarcely be misconstrued. Collateral work examining the problem from the *clinical* aspect is therefore welcome and a number of papers from this angle have appeared in the last few years. For the sake of brevity I shall limit myself to two of the more important of these papers. Thomas and Kinsella undertook the investigation of the urines and urinary tracts of 660 patients who were under sanatorium treatment for tuberculous lesions other than those of the urinary or genital apparatus. They injected the urinary sediment into guinea pigs on six different occasions at weekly intervals. Some of these specimens had been collected over 24 hours and the same guinea pig was used throughout for any given patient. It is a startling fact that 38.8 per cent of these patients had urines which were positive at some time though not necessarily constantly so. Many who at the beginning of treatment showed positive urines at a later time became negative the infection apparently dying out. Investigation by ureteric catheterization showed that *both* kidneys were infected in many instances and a considerable proportion even of these made a complete clinical recovery.

Investigations by Brown, Bertier, Churchman and others running on similar lines and giving confirmatory results could be quoted if

space were available More recently Band (1943) has examined 300 sanatorium patients and has found that over 21 per cent had a bacilluria In 23 per cent of these patients the bacilluria disappeared and the patient recovered In the kidneys of such patients as died Band found minute lesions, mostly of microscopical size, and evidences that some of these had healed All of the above inquiries study infection of the urinary tract in pulmonary tuberculosis but an important paper by Harris of Toronto is so far as I know, unique in having done a like research in cases of bone and joint tuberculosis This investigation originally dealt with adults only, amongst whom evidence of renal tuberculosis was discovered in 37 per cent Later it was extended to include children, of whom 13 8 per cent were found to have tubercle bacilli in the urine These figures are unexpected, for renal tuberculosis in an orthopædic clinic is almost unknown, particularly amongst children

Harris offers as reasons for the discrepancies between the clinically evident urinary tuberculosis and the disease discovered in the laboratory (1) the search for disease when there are no manifestations, (2) the use of guinea-pig inoculation in preference to microscopical tests, and (3) persistent re-examination of the urine over long periods of time That the last is important is shown by the fact that in eleven cases the urine was only intermittently positive

Experimental Methods.—In addition to the clinical research above described, Medlar with Sasano undertook an experimental research which throws much light on the problems of urinary tuberculosis Sixteen animals were given an intravascular dose of tubercle bacilli and at a later time serial sections 30,000 in number were cut from their kidneys The lesions of the cortex and pyramido-cortical areas were separately described and it was found that they do not behave alike This difference appears to me to be essential to a proper understanding of many problems in the pathology of urinary tuberculosis In the *cortex* there was little or no tendency to necrosis but, on the contrary, fibrosis and encapsulation occurred readily and the lesions died out There was no extension into the medulla and it is doubtful if either bacilli or pus cells ever reach the urine from these cortical foci

The *pyramido-cortical* lesions begin near the arcuate arteries They are fan-shaped and resemble infarcts The cortical extension is comparatively inactive but the medullary portions show pronounced necrosis and in all cases leucocytes and bacilli are found in the collecting tubules down to their opening into the pelvis Whatever their size Medlar and Sasano found drainage into the pelvis and it follows that pus and organisms would pass into the urine This contrasts with the lesions in the cortex in which as we have

seen there is no connection with the tubules and no pathological cells can escape in the urine In the one case the lesion is shut off from the pelvis in the other there is free access Medlar and Sasano confirmed this histological fact by re inoculation of the urine into another guinea pig They took the precaution of collecting urine from their inoculated animals and of injecting it into other pigs Two animals which gave negative guinea pig tests were found when their kidneys came to serial section to have tuberculous foci in the kidney but in each instance the focus lay in the *cortex* and no communication with the renal pelvis could be made out histologically It is evident from the freedom of development of these pyramido cortical foci that they are capable of producing the pathological picture seen in the surgical field

It is significant that similar results have been reached by a number of observers working independently and that work on different aspects (clinical pathological and experimental) of the problem is in complete harmony Moreover this work is acceptable for it throws light on several previously unexplained points and the solutions are so apt that they commend themselves to our judgement In what follows I have assumed the correctness of these views

Why should the kidney be the one tissue in the body incapable of overcoming a tuberculous infection? Every other organ and tissue has the power to withstand the disease in greater or less degree Why not the kidney? At first sight its rich vascularity seems to imply outstanding resistance Again the examination of operation specimens of tuberculous kidneys shows numerous places in which a stand is being made against the disease as evidenced by areas of fibrosis calcification and the like On the basis of the work above quoted we find out that the kidney s resistance to the tubercle bacillus is high and indeed is probably greater than that of most other tissues that it is infected with great regularity but that its recovery for the most part is so complete that until recently the resulting cicatrices have eluded us

Renal tuberculosis in itself is a symptomless disease We speak of its silence Neither by pain nor fever nor in any other way does it call attention to itself Only when the bladder becomes involved is the disease announced and for the most part though not always this is a late phenomenon occurring with an advanced renal lesion It now appears that most lesions never pass beyond the microscopical stage They are suppressed early and are rarely if ever recognized by the clinician

A *premonitory albuminuria* has however been a recognized feature of patients who subsequently develop renal tuberculosis

This prodromal albuminuria has never been satisfactorily explained Have we not now the explanation? Does it not represent the period of invasion and evolution? It is known that it may occur before pyuria shows itself and it may correspond to a cortical lesion If the infection is stamped out it will presumably disappear unexplained On the other hand, if the disease progresses it may persist into the period of pyuria and bacilluria

Speed of Evolution of Renal Tuberculosis.—At the present time we know little or nothing about the duration of the preclinical period in renal tuberculosis As a rule the surgeon encounters the case when the focus from which the tubercle-carrying emboli were derived is quiescent or healed Many times that focus cannot be discovered, however painstaking the search The renal lesion has in this event been termed 'primary', a term which is intended to imply that the tubercle bacillus has stolen into the body leaving no mark at its port of entry and has involved no organ other than the kidney This is almost certainly wrong. Many of my own patients show signs of present or past tuberculous lesions They may be divided into two classes (1) Foci such as those in the lung, intestine, and certain lymph-glands, which positions the bacillus reaches *without entering the blood-stream*, and (2) Lesions such as those of bone and joint which are *necessarily hæmatogenous* in origin These groups obviously correspond to the two categories which have been investigated by Thomas and Kinsella and by Harris respectively The *first* group presents a focus from which emboli may be dislodged into the general circulation, a true primary lesion from which the renal infection may have been derived through the blood-stream The *second* group definitely requires the circulation in the blood-stream of tubercle bacilli and probably of tuberculous emboli, and it is reasonable to suppose—nay, it would be a matter for surprise if it did not happen—that the kidney itself is simultaneously implicated

It is not unfair to assume that the time when the kidney involvement started corresponded to a period of activity of the primary disease in the lung or glands or the actual time of origin of the coincident lesion (bone or joint) Some indication may, therefore be available of the interval which may elapse before the renal disease manifests itself by symptoms, an interval which, as previously remarked has given time for the disease to have advanced a long way towards the destruction of the kidney Such intervals can be made out in exceptional cases only In many there is no certain history and an inquiry into them often constitutes a thankless task In some the primary disease runs a prolonged course or suffers relapses so that the moment of the effective renal invasion cannot be decided The preclinical interval is probably a long one, possibly one of many years.

Harris cites a case in which there was a severe illness suggesting miliary tuberculosis kidney trouble manifesting itself ten years later I have had not a few patients confirming this prolonged evolution—for instance a youth of 18 who at the age of 8 suffered from a tuberculous hip which made an excellent recovery Signs of urinary tuberculosis first appeared 10 years later Of course it is impossible to say that this boy's kidney was infected by the same shower of bacilli which started the hip and it is admitted that there may have been other showers of bacilli at a later or even at an earlier time Nevertheless I have seen many similar cases which appeared to support the view that the silent period is long and perhaps this explains the absence of renal tuberculosis in the orthopædic departments of our hospitals and the fact that the age of election for this disease is early adult life The bone or joint disease is healed before the kidney trouble reveals itself Possibly also it explains the absence of urinary tuberculosis in childhood an age of predilection for many types of tuberculosis The systematic examination of urine in an orthopædic department and especially the closer examination by animal inoculation would probably prove instructive

Another deduction may be drawn from these statistics In round figures one third of all cases of pulmonary bone, and joint tuberculosis have been shown in the work quoted above to have involvement of their urinary apparatus But pulmonary bone and joint tuberculosis are common whereas renal tuberculosis (in its advanced surgical variety) is rare It follows that most tuberculous foci of the kidney heal

Bilateral and Unilateral Disease—Another feature which has always resisted explanation is the preponderance of unilaterality of the disease in a surgical practice Probably amongst clinical material there are about 10 per cent of bilateral cases (5 to 15 *per cent*—Israel) On this fact has hung the treatment by nephrectomy Even in specimens obtained from the post mortem room in which the disease would have had ample opportunity of progressing to bilaterality Halle and Motz found 89 instances of unilateral disease in 111 subjects But Medlar amongst his experimental animals found that in 87 per cent the disease was bilateral and it seems reasonable to suppose that in human pathology there is a similar primary incidence of bilateral infection Thomas and Kinsella have indeed shown that if the urine is positive for tuberculosis catheterization will show bilateral infection in 55 5 per cent of cases whereas if the patient dies serial sections invariably show active or healed bilateral lesions On the basis of recent work both sides throw off the infection in the vast majority of cases and of the remainder one or other kidney recovers in approximately 90 per cent The unilateral distribution of the disease

is thus true only of the stage which the surgeon encounters and he must regard the other kidney as having invariably been the site of a tuberculous process which has been overcome

Genital Tuberculosis in the Male.—Genital tuberculosis in the male lies outside the subject, but I must briefly refer to one aspect of the problem It has always been a matter for debate where the first focus of infection within the genital tract occurred Two important schools blame respectively the prostate and the epididymis, whilst Young maintains that the seminal vesicle is the site of primary involvement None of these structures strikes one as at all a suitable recipient for organisms as none has the necessary size or degree of vascularity Have we not now an alternative explanation, not only of the site of origin but even of our previous difficulty in its identification? All the simple inflammations of the genital tract reach it from the posterior urethra As examples may be mentioned purulent spread following operations, including catheterizations and that in gonococcal posterior urethritis If, as is now asserted, tuberculous nephritis and bacilluria are common conditions unsuspectedly complicating tuberculosis elsewhere, is it not more than probable that the genital tract receives its infection from this source by way of the posterior urethra and that this infection may spread indifferently to any or every part of the genital tree, thus bringing it into line with the non-specific infections? The suggestion of this explanation we owe to Harris, and it makes an instant appeal to one's judgement. In support of this view it may be observed that genital tuberculosis is not uncommon after the recent removal of an infected kidney, but that if satisfactory healing of the urinary tract has been achieved as a result of nephrectomy it is very rare for genital tuberculosis to break out afresh (Wildbolz) Again, if the vas is divided and the channel of communication is thus severed tuberculous orchitis never follows

Explanation of the Differences between the Renal Lesion in Miliary and in the So-called Surgical Type of Tuberculosis.—The pathological picture in miliary tuberculosis is very different from that which for want of a better term we call surgical renal tuberculosis In the miliary type the picture is well known, numerous small, discrete tubercles being scattered all over the renal parenchyma

The kidney in surgical renal tuberculosis shows a very variable picture but whatever its type it presents little in common with the miliary variety It is not intended to describe the diverse macroscopic appearances produced by this disease, but I would recall the standard pathological picture in the most usual variety the so-called ulcero-cavernous type It will be remembered that the disease attacks one or more areas situated in the medulla and often near the papillæ Abscesses form which, enlarging, approach the pelvis

and in due time discharge themselves, leaving a cavity lined by tuberculous granulation tissue which communicates with the pelvis by a small or more often by a large opening. By degrees additional papillæ and pyramids of Malpighi are added and the medulla in part or wholly disappears, leaving the renal aspect of the pelvis as a ragged ulcerated area through which the cortical tubules must drain into a much altered renal pelvis. The cortex appears to be more resistant to tuberculous processes and withstands excavation until a later time.

If the very earliest stage of the disease is discovered in an operation specimen the lesion is limited entirely to the medulla and often to the tip of a papilla. In the latter situation foci show a preference for the fornix calicis and tubercle bacilli may be found in these niches in abundance. When there is extensive disease of the papillæ with little involvement of the parenchyma the condition has been referred to as a primary open tuberculous pyelitis. Caulk affirms that if serial sections are made in such cases the majority will have an initial lesion in the renal substance, whilst Medlar has demonstrated ulceration of a papilla and in the corresponding medulla a focus which was macroscopically invisible.

Sufficient has been said to emphasize the difference between the acute miliary type of the disease and the chronic caseous surgical or ulcero-cavernous variety. These differences set a rare pathological problem for solution at the time when it was first realized that tuberculosis of the urinary tract had its primary seat, so far as that tract was concerned, within the kidney. Miliary tuberculosis was admittedly a blood-borne infection. But could the chronic caseating lesion likewise be blood-borne, and if so why the marked differences in type and distribution, and especially why was one a bilateral principally cortical condition and the other a unilateral medullary lesion? The differences seemed too great to be compatible with a common route of origin and to explain them the hæmatogenous view had to compete with a lymphogenous theory and a view which still adhered to the possibility of ascending infection. The lymphogenous theory is now discredited and it is unnecessary to discuss it.

Ascending Infection.—Obviously the primary distribution of the disease in the parts of the kidney nearest to the pelvis might have been satisfactorily accounted for by the ascending theory. The view that tuberculosis occurred first in the bladder and that it spread thence to the kidney received its quietus about the time that cystoscopy came into common usage. Frequent observations then showed that tuberculosis of the kidney could and did for long periods exist with a healthy bladder, that in course of time the bladder might become involved and that the first signs of bladder invasion could

be seen cystoscopically to take origin around the ureteric orifices and from there to spread to other sections of the viscus Moreover, it was found that if the kidney was removed the bladder lesion receded or disappeared The post-mortem room provided confirmation when tuberculous kidneys were discovered before any vesical disease had as yet supervened

But if the ascending route is proved not to be the customary one it can nevertheless not be entirely excluded as an occasional, or at least a possible, method of renal involvement It is now recognized that by implanting tubercle bacilli in the ureter a renal tuberculosis can be produced, and that this can be the more easily accomplished if the ureter is subsequently tied But Wildbolz has produced the same results by placing tubercle bacilli in the bladder and electrically stimulating the ureter in such a manner as to produce strong peristalsis and reflux peristalsis The tuberculous bladder is exceedingly irritable and hypertonic and is reduced in size It is Wildbolz's opinion that excessive contractions of the tuberculous bladder in man can be responsible for originating a tuberculous process in a previously healthy kidney, and this would appear specially liable to occur if the tuberculous bladder is washed out as a therapeutic measure or is carelessly handled at cystoscopy The writer thinks, moreover, that the catheterization of a healthy ureter across a tuberculous bladder is a procedure which should not be undertaken quite as lightheartedly as is sometimes done, and that possibly in some of those patients whose second kidney shows signs of tuberculosis at some time later after a promising nephrectomy the infection may have been implanted by the surgeon himself

Hæmatogenous Infection—Reference has already been made to the difficulty experienced in explaining the differences between the miliary and the chronic varieties of renal tuberculosis For a time experimental work directed to the elucidation of this problem completely failed to supply a solution Such work chiefly took the form of injecting tubercle bacilli into the circulation and studying the result on the kidney It invariably produced a lesion which mimicked absolutely that of miliary tuberculosis and was bilateral

The work of Pels Leusden first proved that the hæmatogenous route can produce a chronic medullary lesion His important contribution is so far as I know, most curiously neglected in the relevant English literature He realized that previous investigations failed because bacilli in too great number and of too great virulence had been used and also probably because animals too sensitive to tuberculosis had been employed Using less susceptible animals (goats and dogs), and weak strains of bacilli in restricted quantities Pels Leusden succeeded even at his first venture, in reproducing as a result of

intravascular injection lesions of chronic renal tuberculosis which in every respect simulated those seen in human surgical work He said as a result of this first research I am convinced that a different method and not a different route of infection is responsible for differences in the microscopic appearances' This important investigation produced the experimental proof which had hitherto been lacking that not only the acute miliary type but also the chronic surgical type of renal tuberculosis can result from a hæmatogenous infection It is interesting that a precisely similar observation was made by Koch when working with staphylococci He found repeatedly that if small doses of weak staphylococci were injected into the blood streams of animals the resulting renal abscesses proved to be medullary in distribution and were often unilateral If however the dose was large and the organisms virulent the resulting disease was bilateral and the cortex and medulla were equally affected

The work of Pels Leusden is complementary to that of Medlar and Sasano Taken together they show how an intravascular dose of tubercle bacilli affects the kidney The primary arrest is in the terminal arteries—the arcuate glomerular intertubular arteries and the vasa recta The incidence of infection is highest in the cortex but here also the resistance is high and all or almost all the lesions die out unless the dose is excessive The cortico medullary and medullary lesions are numerically fewer but these sites are less resistant If therefore the kidney is overwhelmed by a large dose the picture is that of miliary tuberculosis If on the other hand the dose is small all cortical lesions die out and also many most or all of the medullary ones Any medullary lesion which survives may extend and gradually destroy the kidney The pathological picture is that with which we are familiar in the chronic surgical tuberculous kidney The fact that in most instances the infection is overcome accounts for the unilaterality of this disease at the time it reaches the surgeon

Does Excretory Bacilluria Exist?—By excretory bacilluria is understood the filtration through the kidney of tubercle bacilli circulating in the blood there being no tuberculous focus in the kidney itself A multitude of contradictory statements have been made on this subject many of them all supported by careful work and therefore very unconvincing The significance to be attached to the presence of tubercle bacilli in the urine hangs on the correct clearing up of this question It is obvious that no authoritative pronunciation can be made in any case where bacilli are found in the urine unless serial sections have been made of the whole of both kidneys It was for this purpose that Medlar originally undertook his investigation It is therefore interesting to note that in his experience renal

tuberculosis was found histologically in every animal whose urine gave a positive inoculation The author draws special attention to one animal which had given a positive test and in which only two lesions were discoverable one quiescent and the other very active The latter lesion was, however, very small and invisible to the naked eye "Had serial sections not been made ' writes Medlar, "this lesion would have been entirely overlooked and we would have had a very good example of tuberculous bacilluria " In Thomas and Kinsella's investigation which has been quoted above it was similarly found that positive urinary findings meant a renal lesion, and, moreover, this was invariably bilateral

Harris has approached this question from a different angle A neat experiment was suggested to him by Professor Klotz The sediment from daily specimens of urine collected from a tuberculous subject was injected into a separate guinea-pig each day for ten consecutive days *Each guinea-pig developed tuberculosis* Tubercle bacilli were therefore, present in the urine each day The experiment was repeated for other patients a proportion of whom gave similar results These patients were however free from urinary symptoms and it was argued that if they had suffered from tuberculous bacillæmia of such a severe grade there would have been miliary tuberculosis. Blood-cultures were, however, free from tubercle bacilli

It seems to the author that these facts go far to answer the question whether a tuberculous bacillæmia can exist and that probably in the future we shall regard the presence of bacilli in the urine as evidence of a focus in the kidney, not necessarily a focus calling for surgical interference and not necessarily incapable of healing

How do these Facts affect the Clinician ?—

1 It is obvious that the discovery of evidences of renal tuberculosis in the urinary apparatus of patients suffering from the same disease in some other system, if it can be repeated on the large scale, presents important problems and possibilities in the field of preventive medicine

2 To the surgeon the problem is but little altered The disease with which he deals has been brought to light as the result of symptoms and is therefore, late and advanced (*see* page 105) The condition is a renal phthisis and it remains true that in this stage it is incapable of spontaneous recovery In the absence of contra-indications the treatment is nephrectomy

3. Symptomless bacilluria will require thoughtful consideration Combined with an active focus elsewhere it will probably not call for surgical interference Ureteric catheterization function tests and pyelography will help to assess its significance

CHAPTER VII

TUBERCULOSIS OF THE URINARY TRACT

URINARY tuberculosis is one of the most interesting and important diseases coming within the province of the urologist and its interest is maintained not only pathologically, as already seen but also in diagnosis and treatment In diagnosis the advent of excretion urography has encroached on the field of cystoscopy by introducing an important additional method indeed some urologists go so far as to regard it as a self sufficient alternative Whether this is a correct view will be discussed later for the present it is enough to point out that an excretion urogram should be obtained and studied *before* cystoscopy is arranged as it gives important information about the state of the urinary tract which will prove invaluable when the case comes to cystoscopy By urography the operator learns a great deal of what he wants to know about the case and this saves much preliminary hunting in the bladder and such additional information as he needs can be acquired expeditiously Valued at its lowest excretion urography has done away with the prolonged and often multiple cystoscopies which were previously only too common It precedes cystoscopy in many other conditions but it is particularly desirable that it should do so in urinary tuberculosis because the surgeon often finds himself in difficulties owing to vesical irritability and intolerance advanced urinary tuberculosis being one of the most difficult of all complaints from the cystoscopist's standpoint and one in which any preceding information is to be welcomed as helping and speeding the cystoscopy As not all inflammatory diseases of the urinary tract are immediately cystoscoped and otherwise fully investigated (pages 76 92) it becomes necessary to pick out early those which will probably prove to be tuberculous The following features in the history help to differentiate tuberculous from simple cystitis —

1 The symptoms of cystitis are generally well marked The most distinctive feature about this cystitis is its insidious onset the patient rarely being able to tell with any precision when his symptoms started

2 The progressive nature of the disease which is but little influenced by medical treatment This however is sometimes masked by temporary intermissions in the symptoms

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1 The symptoms of cystitis are *generally well marked* The most distinctive feature about this cystitis is its insidious onset the patient rarely being able to tell with any precision when his symptoms started

2 The progressive nature of the disease which is but little influenced by medical treatment This however is sometimes masked by temporary intermissions in the symptoms

3 The age incidence is almost limited to the years between 20 and 45

4 The presence of pus in urine which is generally acid and is sterile on culture I always regard with suspicion a purulent urine which is found to be sterile on culture

5 The presence of other tuberculous lesions, or a family history of tuberculosis

6 Polyuria, which is best marked in the early stages.

Unfortunately it is not always easy to label the condition as tuberculous prior to the cystoscopy. and in such circumstances the cystoscope may supply the first hint that it is so Whenever one examines a bladder for cystitis of unknown origin, and especially if the case has run a protracted and resistant course, the possibility of the lesion being tuberculous should be borne in mind during the preparation and study of the vesical mucosa

Ultimately, of course, the finding of the organism is the essential thing and that is a pathological problem In the search for it it is customary to use not only stained smears but also guinea-pig inoculation In the laboratory at the Salford Royal Hospital the Ellerman and Erlindson ('E and E')* method has been employed for many years It has proved itself extremely reliable and in the vast majority of cases gives an accurate result within 24 hours The high level of concentration and the reduction of solid material to minute proportions makes positive results more numerous and negative reports very reliable Acid-fast organisms, other than Koch's bacillus, do not survive the digestion stage and so are excluded So much has the 'E and E' method the writer's confidence that for him guinea-pig inoculation has become almost a thing of the past It is scarcely necessary to draw attention to the valuable saving of time as compared with the guinea-pig test The method, which appears to be little known, deserves greater attention

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* The Ellerman and Erlindson test for tubercle bacilli (digestion method) —

Solutions required	Sodium Carbonate	0 6 per cent
	Sodium Hydrate	0 25 per cent

Into a sterile test-tube pour 5 to 10 c c of deposit from the spun urine to be tested

Add sufficient 0 6 per cent sodium carbonate to three parts fill test-tube Shake thoroughly

Incubate at 37° C for 24 hours Mucus is all absorbed in incubation period

After incubation centrifugalize for 10 to 15 minutes at high speed Pour off supernatant fluid

Add to residue 10 to 15 c c of 0 25 per cent sodium hydrate and bring to boiling-point This dissolves any pus left over from incubation period

Centrifugalize again for 10 to 15 minutes

Pour off supernatant fluid and prepare a film from remaining deposit The deposit will chiefly consist of debris and organisms.

Stain by Ziehl-Neelsen method

Preparation of the Patient—

Anæsthesia—Good anæsthesia is more than usually important in the cystoscopy of a tuberculous bladder owing to its size and its liability to empty itself spontaneously. For early cases local anæsthesia may prove sufficient, but at a later stage spinal anæsthesia is more satisfactory than any other variety as, by controlling a wider area, especially centres in the lumbar region, it gives the deepest relaxation obtainable.

Preparation of the Bladder—As with tuberculosis elsewhere the damaged mucosa of these tuberculous organs is highly susceptible to secondary sepsis and so calls for the most rigid aseptic ritual, as a mixed infection will greatly aggravate the patient's sufferings.

In lavage, as already emphasized, overdistension is to be avoided as it leads to further reduction in capacity and to hæmorrhage. The lotion should be injected very slowly and rise in quantity by easy stages, the first wash being 1 oz, the second 2 oz, and so on (page 77). The surgeon will note on his syringe the quantity which can be safely employed and will limit his subsequent injections accordingly. If hæmorrhage occurs it may be disastrous, though as a rule it can be controlled by adrenaline (30 min. of the 1 in 1000 solution to one pint of bladder lotion).

Even when the bladder is very small ('thimble bladder') a satisfactory examination may generally be attained provided it can be cleared of pus and kept free from hæmorrhage. Actually reduction in size has its compensations in that the walls are closer to the lamp and prism, and therefore illumination and magnification are good. I have on many occasions catheterized both ureters in a viscus whose capacity was less than 3 oz.

Intolerance of the bladder during preparation, and its small size, have often been responsible for rousing one's suspicions as to the nature of the disease. Their degree cannot always be accurately forecast prior to commencing the preparation of the bladder, for they do not necessarily run *pari passu* with urgency of micturition; in fact some patients with distressing diurnal frequency and nocturia will yet be found to have bladders of normal or almost normal capacity. Nevertheless the severer grades of urgency will usually be found in the more profoundly damaged and diminished bladders. Early ones are for the most part relatively easy to prepare and examine.

Sometimes in spite of all skill and patience the examination fails. The patient should then be put to bed for a week or ten days on a fluid diet and have hot applications to the hypogastrium and perineum. Two drachms of cod-liver oil three times a day and bladder sedatives should be administered by mouth. At the end of

this time cystoscopy should be repeated under spinal anæsthesia, when it will probably be found that the bladder is easier to deal with. But this is precisely the kind of case in which excretion urography should be relied on to the exclusion of cystoscopy (page 129), always granted that the films give reasonably solid grounds for confidence.

Object of the Cystoscopic Examination.—The predominance of symptoms of cystitis which is such a marked feature in this disease, was responsible for the view held years ago, that the bladder was the primarily affected organ, and that the kidney became secondarily infected. Now we know that the kidney is primarily at fault, that almost invariably the disease is unilateral when first seen by the surgeon, and that the bladder is affected secondarily. We know also that if, with satisfactory findings in the better kidney, we remove the affected kidney the prognosis will be good, both as regards the bladder, which will heal, and as regards the other kidney which is not very likely to show signs of infection later. Until recently, as shown in the chapter on pathology, it was believed that when the disease showed itself in the supposedly healthy kidney it was due to infection ascending from the bladder. Though this route of infection is not entirely ruled out (page 110) we now realize that the disease is bilateral from the beginning and the focus in the presumed healthy kidney is an original one which evolved more slowly than the one in its neighbour.

These elementary statements foreshadow the data required of the cystoscopic examination. From them it will be seen that the surgeon :—

1. Must *confirm the diagnosis* of tuberculous mischief by noting the cystoscopic appearances. (In the event of this not having been suspected up to the present, he should be led by the vesical examination to a diagnosis of the same.) Whilst this confirmation rests mainly on the intravesical manifestations—which will be studied later—much useful information may be gained by observing the behaviour of the bladder during preparation.

a. Its small size and irritability have already been referred to.

b. The speed at which the organ washes clear frequently indicates that the pus present in the urine has been derived mainly from the kidney. If the bladder itself is little involved, it will be possible to obtain a clear wash-out after the first two or three attempts.

c. The type of urine obtained has certain peculiarities. It is generally acid. Its appearance is modified by the presence of tuberculous pus, which has a pale yellow-ochre tint. As there is usually a comparatively slight admixture of mucus owing to the small area of vesical involvement, the pus settles quickly to the bottom of a specimen glass as a flat creamy layer with no flocculent mucus above

it such as occurs when the cystitis is diffuse The inference is that it is derived from a renal lesion However isolated flocculent masses suspended in the urine above the deposit or adhering ubiquitously to the sides of the containing beaker are somewhat characteristic, but they are quite different from the billowy appearance which is presented when pus is floating on mucus These features are masked when secondary infection supervenes

2 Must seek evidence as to the *kidney primarily affected* The excretion urogram and the cystoscopy both play major roles in

Fig 68—Marked calcification of a large tuberculous kidney Nephrectomy r ov ry (*Radiograph by Drs Barclay Later on and Dunning*)

discovering which is the diseased organ but evidence collected clinically precedes these and should never be neglected Three purely non-instrumental methods are employed —

a Renal palpation In this examination it should be remembered that there is some danger of mistaking a hypertrophied and possibly tender healthy kidney for the diseased one In many instances the tuberculous organ is actually *diminished in size* A really large kidney is almost certainly pathological

b Rectal or vaginal examination whereby the thickened lower ureter may be felt

c Radiography (additional to urography) which may show disease of the kidney especially when calcification has occurred (*see Figs* 68 and 235 page 391 also 238 page 394) the presence of

the opposite kidney, and the existence of tuberculous foci in the lung, mediastinum, or retroperitoneal tissues

The cystoscopic methods of diagnosis are discussed later

3 Must examine the *condition of the opposite kidney* This is dealt with on page 125 and in Chapter XXI

BLADDER APPEARANCES IN URINARY TUBERCULOSIS

The lesions regarded as characteristic of tuberculosis of a mucous membrane are the so-called tubercle and tuberculous ulceration In the bladder the picture observed through the cystoscope may or may not show these lesions but the diagnosis of urinary tuberculosis is not in a typical case made by observing such specific signs An actual tubercle is somewhat rare, and tuberculous ulceration is often masked by other pathological changes in the mucosa so that the cystoscopic diagnosis is generally arrived at by observing the distribution and severity of the vesical lesions rather than by their specific nature In practice it is found that the bladder picture in vesical tuberculosis is similar to that of other forms of severe cystitis in which ulceration and polypoid hypertrophy occur The cystitis is limited as a rule to the neighbourhood of one or other of the ureteric orifices up to the time that secondary infection with pyogenic organisms is superadded, when it spreads to the remainder of the bladder

Vesical changes may be absent Before discussing the vesical changes it should be pointed out that a number of cases of renal tuberculosis occur in which there is no intravesical disease Some of these are early cases where the bladder appears to have resisted infection, and some result from ureteric occlusion

A closed ureter (auto-nephrectomy) in renal tuberculosis occurs in about 10 per cent of cases Not only does it shield the bladder from infection, but it also hinders the diagnosis by excluding pus and bacilli from the urine Here again the intravenous pyelogram will certainly assist by pointing out a dead kidney Investigation of the renal function will also demonstrate the absence of excretion from that side and may lead to a correct diagnosis when taken in conjunction with other signs pointing to the development of a pyonephrosis Occlusion of the ureter is due to sclerosis and is therefore a moderately late phenomenon On occasion it is associated with extensive calcification in the kidney and its contents as seen on the plain film (*Figs* 69 235 and 238) Generally some bladder infection will have occurred before the closing down of the tube Further when sclerosis has occurred to such an extent there will usually be some shortening of the ureter which will give rise to retraction at the meatus and deformity of the bladder Therefore it is only in comparatively

rare instances that there is a complete lack of cystoscopic evidence Nevertheless a good many of these cases with occluded ureters remain undiagnosed until late whilst in some the tuberculous origin (bacilli being excluded from the urine) is not appreciated though the diagnosis of pyonephrosis may be made

Hæmaturia may occur before there is any vesical involvement It is then renal in origin and may be the first symptom It occurs principally in that type of disease which early affects the renal papilla In order to trace it to its anatomical source cystoscopy must be performed during an attack of bleeding It may even then be difficult to attribute it to its correct pathological cause though in this type the bacilli will probably be found abundantly in the urine

Pyuria is also occasionally observed before bladder changes have supervened and before any symptom has shown itself though as a rule it is preceded or accompanied by frequency of urination Obviously if there are no symptoms pyuria will almost certainly pass unnoticed and as the symptoms are caused by disease in the bladder (page 106) pre clinical pus will not be recorded save exceptionally Unless the pus is unusually copious for so early a stage it will escape detection by the cystoscope (*see* page 369) Ureteric catheterization would however locate its source

Early Lesions —

Hyperæmia —Hyperæmia at the ureteric orifice is the earliest vesical sign of a tuberculous kidney This of course may occur in any form of renal irritation and is not pathognomonic of tuberculosis It may be due in part to the irritation of abnormal and infected urine and then shows itself as a cone shaped area of redness having its apex at the ureteric orifice and its base towards the meatus

As time goes on the meatal hyperæmia becomes more evident from the continued passage of irritating fluid along the ureter Infiltration and stiffening of the orifice follow and the ureteral wall is soon invaded by tubercles It becomes raised above its usual level in relation to the bladder wall, and at the same time its mobility disappears so that when an efflux occurs it is unaccompanied by the characteristic elevation and contraction and the orifice becomes inert and assumes a passive role The effluxes however at this stage are abnormally frequent owing to the polyuria which occurs from the diseased organ at this period and also on account of the irritating qualities of the urine

Tubercles —It may be repeated that though the tubercle and tuberculous ulceration are the lesions typical of this disease they are not frequently observed that in fact, they are generally lost amongst other lesions which are in no way characteristic of the complaint

Tubercles when seen occur in the first instance near the ureteric orifice which corresponds to the diseased kidney and often on its very margin (*Fig* 69) Usually they involve the mucosa of the bladder proper rather than that of the trigone—a fact which would seem to indicate considerable resistance on the part of the latter structure for the jet of infected fluid travels downwards and inwards over its surface They show a predilection for the mucosa overlying and surrounding the intramural ureter, where their presence is probably accounted for by direct spread from that infected tube From the vicinity of the meatus the disease travels upwards and inwards towards the fundus, where it may develop freely For some time however, it remains limited to one side of the bladder

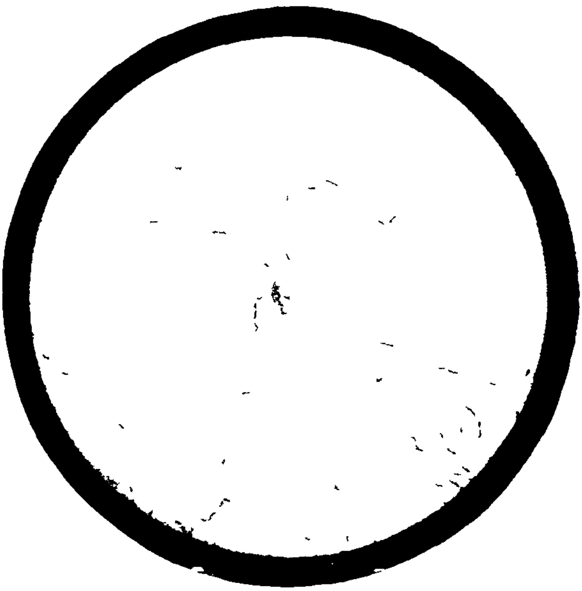


Fig 69 —Early tuberculous disease of the bladder Ureteric orifice shows minor hyperæmia and a tubercle on its lip Other tubercles nearby

Next in frequency to the above-mentioned areas, tuberculous infection involves the summit of the organ (*Fig* 70) Probably this occurs even more commonly than has been recognized for the surgeon's attention being absorbed with the area of ureteric involvement, he is liable to neglect the apex of the viscus It often repays a search for the picture presented there is of more recent development and on that account may be more distinctive than the one in the neighbourhood of the ureter On occasion I have obtained valuable help from an inspection of this area Pilcher reported a case in which it was the only one involved, and I too have seen a similar occurrence The infection of this region is probably due to tissue contact when the viscus is empty and as micturition occurs frequently the two areas of mucous membrane are often in apposition

Tuberculosis of the seminal vesicle may spread to the bladder and then involves an area lying immediately behind the ureter The ureter itself shows no change until encroached upon secondarily by the extension of the process Tuberculosis may also spread from the prostate (*see* page 281)

In the very earliest stages the tubercle is said to be translucent but it is rarely seen in this condition Later it progresses through white grey and finally yellow as caseation advances (*Plate IV* A) It is surrounded by a narrow ring of congestion quickly fading away into the normal healthy or perhaps slightly injected vesical mucosa Close inspection with the cystoscope can detect the small vessels entering into the formation of these areolæ

The tubercles are generally closely related to the blood vessels A solitary tubercle may be perched on a large vessel, or more frequently at the junction of two vessels and multiple lesions may be seen like granules situated along the ramifications of a branching artery

Single tubercles are uncommon they usually occur in groups and these are not widely disseminated over the bladder surface but are as a rule confined to a few circumscribed areas

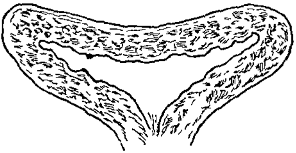


Fig 0 — Shows how infection by contact is responsible for the involvement of the summit of the bladder

Ulceration —The tubercles rupture sooner or later leaving an area of ulceration similar in extent to that which they previously covered In the bladder the ulcer has the same appearance as tuberculous ulceration elsewhere presenting a shallow *crateriform* cavity with undermined margins The edges are *irregular in outline* but may be difficult to discern clearly The base is frequently *covered with slough* and this may overlap so as to hide the ulcer On the margin of the ulcer at irregular points and sometimes surrounding it completely as a ring may be seen tubercles which have not yet ruptured but which will shortly do so thereby enlarging the area of ulceration When first formed the ulcers are shallow but as time passes they increase both in depth and in superficial extent and they may coalesce with neighbouring ulcers The principal sites are the immediate vicinity of the ureteric orifice and the fundus

Bullous Œdema (*Plate IV* D and E) —The tuberculous bladder is a favourite place for the development of bullous œdema Few bladders are seen in which some is not present and it may be extremely marked It frequently surrounds and may entirely hide the ureteric

orifice. Occasionally it protrudes into the bladder cavity like a mass of spawn.

When cystitis is severe it is accompanied by the formation of numerous polypoid excrescences (*Plate IV* F) similar to those described on page 85. These often reach from the neighbourhood of the ureter up into the fundus and may involve large areas of the viscus

Late Lesions.—Finally, secondary sepsis may be added When this unhappy complication has supervened the mucosa becomes uniformly reddened swollen and velvety, and may show many œdematous masses It bleeds easily loses its lustre, and reflects light badly The bladder diminishes rapidly in capacity and becomes more refractory than ever Indeed it now presents one of the most difficult problems which the cystoscopist ever encounters and requires much tact and judgement in its handling Unfortunately this is a stage at which too many patients especially amongst the hospital

PLATE IV

A, Four closely set tubercles near a vessel Mucosa pink Note stippled appearance of the membrane B, Tuberculous ulceration on fundus Upper margin slightly undermined Tubercles on lower edge and at lower and outer margin of circle Small slough on base of ulcer C, Numerous tubercles on a much swollen and pleated mucosa D Right ureteric orifice—ulcerated and excavated Tubercles and purulent slough on margins Bullous œdema below and external Cystitis of moderate severity E, Tuberculous ulceration Intense cystitis Translucent bullæ F Catheter in ureter corresponding to healthy kidney Cystitis has spread across and surrounds this orifice Polypoid swelling, such as may be encountered in any form of severe cystitis, is well depicted

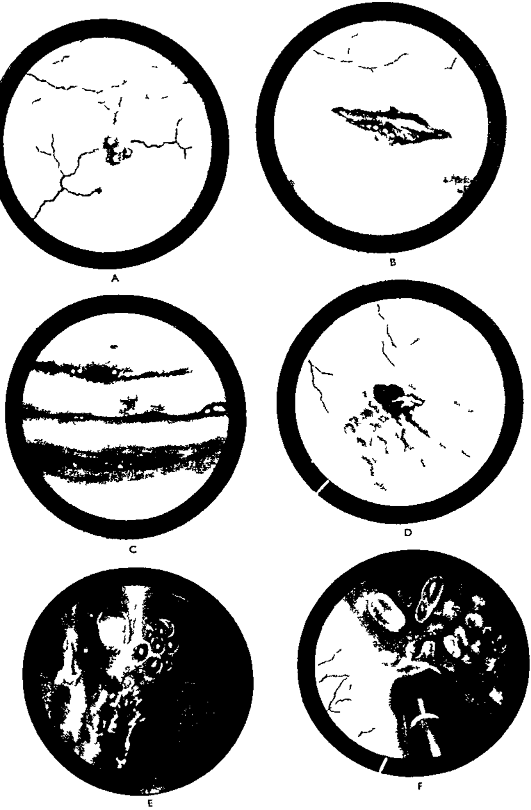
class, reach the surgeon In some instances it undoubtedly dates from unsterile instrumentation

Changes around the Ureteric Orifices—The changes occurring at the ureteric orifice as a result of infection from a tuberculous kidney have already in part been described Hyperæmia swelling and tubercle formation have been noted It has been shown that the tubercles affect the lips of the meatus When these ulcerate the orifice assumes a variety of appearances according to the relative parts played by ulceration and œdema If ulceration takes the chief role the margins are irregular in outline and appear moth-eaten the meatus is open and may be conspicuous If, however œdema is marked the meatus is encroached upon and may be quite closed so that great difficulty may be experienced in identifying it In the worst cases the swelling goes hand in hand with the formation of polypoid inflammatory masses and then the ureter may be unrecognizable amongst numerous crypts recesses and other irregularities

When the tuberculous process is well established in the ureter the walls become thick, rigid and pipe-like This is reflected in the appearance of the orifice itself, for now, in addition to being elevated

PLATE II

TUBERCULOSIS OF THE BLADDER



the mouth is gaping rigid and motionless Tubercles are seen on its margin which may be likened to the orifice of a crater Finally, when the ureter is sclerosing and so becoming shortened, the orifice is dragged up towards the kidney and lies at a higher level on the bladder wall causing the trigone to become distorted It often appears to occupy the deepest point of a conical recess and its lips are no longer elevated as formerly The term golf hole ureter has seized the imagination of the profession and is often incorrectly applied to the elevated and gaping crateriform orifice of the middle period Its correct application is to this retracted orifice of the late stage The shortening of the ureter is responsible not only for its retraction but also for the straightened ureteric shadow seen so characteristically on the pyelograms (*Figs* 73 and 80)

When secondary sepsis occurs it usually obliterates all characteristic features completely, and brings the second ureteric orifice to a common level with the primarily affected one the only cystoscopic appearances presented being those of intense cystitis Inspection alone may be unable henceforth to decide which is the affected kidney To the cystoscopist both ureters now appear to have changed their position and to lie high on the posterior wall facing him an impression which results from the fact that when the radii of the bladder diminish the trigone takes little or no part in the contraction (*see also* page 89 and *Fig* 67)

It will be seen from the above description that the cystoscopic appearances may be either characteristic or non characteristic In the former class lie the tubercle and tuberculous ulceration, though the latter may be mimicked closely by simple ulceration which of course is rare In the latter category lie the early and the late phenomena—namely total absence of change ureteric hyperæmia bullous œdema and the manifestations of secondary infection—all of which may occur in other urinary diseases The distribution and severity of the pathological changes however are suggestive up to the time when secondary contamination reduces all parts of the organ to a common level However the cystoscope may fail in making a diagnosis not only on this account but also because even the characteristic lesions are frequently hidden tubercles may be lost from view between folds of œdematous mucosa and ulcers may be covered with sloughs and debris or bleed as the result of manipulation so that clots hide them from view

DIAGNOSIS OF THE KIDNEY PRIMARILY AFFECTED

This part of the examination has been revolutionized by the coming of excretion urography which if carried out prior to

cystoscopy, will in a great majority of cases discover which kidney is the principal or only victim Previously such work devolved entirely on the cystoscope and though varying widely from case to case, it was often extremely difficult, and trying alike for the patient and for the surgeon How great is the benefit derived from a previous urogram will hardly be appreciated by those who have not lived through this phase of urological history When one kidney is known to be definitely tuberculous interest will naturally be centred on the opposite organ and the cystoscopist will merely glance at the diseased orifice to remark the extent of the change If the bladder disease is still one-sided the actual orifice probably remains visible with the opposite ureter showing little, if any, change Catheterization of either will be straightforward At a later stage the affected ureter cannot be identified and this, in the most advanced instances, is true also of the second ureter The difficulties of catheterization of either ureter in these circumstances are obvious In the old days catheterization of the *diseased* ureter was almost obligatory Now it is less in favour For the moment its technique will be described, leaving the question of its desirability for discussion later

Catheterization of the *diseased* ureter may be complicated in several ways It is often impossible to see an orifice which is hidden by ulceration, pus, or œdema Where the area of pathological change is small and is obviously covering the site of the ureter, a catheter may sometimes be passed by palpating the surface of the diseased area with the tip of the instrument Frequently it runs home at the first or second venture Chromocystoscopy (*see* page 424) may be employed as a colour indicator in the hope that it will show the position of the orifice, but though very valuable in assisting the discovery of the ureter corresponding to the healthy kidney, it is less successful in showing that on the diseased side owing to excretion being late and feeble

Even after penetration has been accomplished, difficulties may still be encountered The ureter may be strictured, and the catheter will then be held up Tuberculosis of the ureter affects the upper and lower segments of that tube first, the middle section is involved later Strictures, therefore, occur in the upper and lower thirds of the tube rather than in the middle Even where the catheter does not pass it will sometimes be possible to collect urine, as the stricture though impassable to a catheter, may yet be permeable to fluids Conversely the ureter may be dilated so that urine and pus elect to escape into the bladder alongside the catheter rather than through it and little or nothing will be collected Again, even if the catheter does pass freely it may be blocked by debris which it has collected during or subsequent to its passage It is always expedient, therefore,

to force a few minims of sterile lotion through the lumen by means of a syringe as soon as the instrument is in situ

EXAMINATION OF THE OPPOSITE KIDNEY

Regarding this kidney we want to know (*a*) its functional capacity and (*b*) whether or not it also is tuberculous

a Renal Function—Its function may be judged by chromocystoscopy by an excretion urogram (*see* page 129) or by catheterization combined with a dose of phenolsulphonephthalein (*see* page 426) or urea (*see* page 420) *Chromocystoscopy* (*see* page 424) is the method favoured by the author It serves not only to indicate the presence of a kidney on that side but will if the efflux is copious be fair evidence that this kidney will carry on the work of the body Undue importance should not be given to the period of onset of the elimination of indigo carmine for this drug is sensitive to insignificant lesions of the kidney and it is well known that the second organ in renal tuberculosis is quite often temporarily affected by some degree of secondary nephritis Particular attention should therefore, be paid to the copiousness of the efflux when at its height *Chromocystoscopy* gives no information regarding the cytology of the urine derived from the organ which is expected to carry on after its diseased neighbour has gone This may be of little moment in a disease which has no tendency to be bilateral but it is important in renal tuberculosis which early or late may affect the opposite gland (page 107) but this deficiency can be corrected by ureteric catheterization

b Health of the Opposite Kidney—The question whether the opposite kidney is free from tuberculous disease is clearly of first rate importance but is less simple to answer than the former question regarding function though a high capacity is itself suggestive of a healthy kidney We may seek the answer by separating the urine through ureteric catheterization and studying its contents or we may rely on an excretion urogram (*see* page 131) The former should be the more searching test but it is open to certain fallacies

Ureteric Catheterization—If the carmine test has been employed the catheter is passed immediately an adequate dye elimination has been observed Examination of the specimen collected is made especially for albumin casts leucocytes and tubercle bacilli Albumin and casts are often found and do not in themselves constitute a contraindication to operation They are evidence of the effect produced on the opposite kidney by the disease in its fellow and generally disappear in course of time after nephrectomy

Pus Cells—A complete absence of pus cells from the urine is tantamount to saying that there can be no inflammatory trouble, when they are found and they are not at all uncommon they may

come from a tuberculous focus, but the surgeon should not jump to the conclusion that this is so for they may equally be non-specific in origin. Emmett and Braasch have stressed the value of a pus cell count of the urine from this kidney. According to them, when the spun urine contains not more than three pus cells per high-power field the likelihood of finding acid-fast bacilli is small. Above this level the chances "are very great that inoculation of guinea-pigs will reveal the presence of *Bacterium tuberculosis*" and, as the routine staining of the urine obtainable by ureteric catheterization is liable to be negative, because of its small quantities, an estimation of the number of pus cells is "highly important as a diagnostic procedure." *See also* discussion of white blood-cells in urine, page 86.

Tubercle Bacilli.—In all examinations for bacilli from a 'healthy' kidney there is a manifest fallacy—namely, that in passing through a diseased bladder bacilli may be picked up either on the catheter itself or in the bladder fluid which enters its lumen. The guinea-pig test will exaggerate this fallacy much more readily than the microscope, leaving in the surgeon's mind a lurking suspicion that he may have found tuberculosis where it did not exist. This suspicion is emphasized by a consideration of the operative results in two series of cases published by Morse and Braasch. In each series microscopy of the urine and pyelography were satisfactory, but in one set the guinea-pig inoculation was positive, in the other negative. Nevertheless, the operative results were similar, which seems to suggest that too much importance can be given to this test. Some writers also think that a reflux of urine up the ureter may account for bacilli in a healthy ureter.

An alternative explanation of the good after-history in those cases where the guinea-pig test was positive is that the kidney had in due course healed. At any rate, whatever the explanation, it is evident that the discovery of bacilli in the catheterized specimen from the supposed healthy kidney is not necessarily a valid reason for refusing to remove the more severely damaged partner. The work of Medlar, Thomas, and Kinsella and others explains and supports this statement and proves that such organisms may come from small foci capable of healing (*see* pages 102–105). It emphasizes that the disease is a general rather than a local one, and the desirability of sanatorium treatment subsequent to nephrectomy. So we see that, even though both sides are infected, one will be found in the majority of cases to have passed beyond the stage at which recovery is possible, but not necessarily the other.

The possibility of carrying organisms to a healthy kidney by ureteric catheterization has also to be taken into account (*see* page 110) and, as a safety measure, we do not advance the catheter as

far as the kidney This danger is said by many to have been disproved Simon (1932) for instance says that the experience of twenty years has shown it to be without foundation Nevertheless the present writer has always been apprehensive Retrograde pyelography is obviously more unsafe than simple catheterization and as it rarely gives information which cannot be acquired by other means, it is falling into disfavour

Double Catheterization —Double catheterization was often undertaken in the past but is seldom carried out now

If catheterized, the quantity of urine obtained from the two opposite sides is rarely identical In an early case the diseased organ secretes an abnormal quantity of pale fluid of low specific gravity Later, as destruction advances the amount of urine diminishes and the pus increases At this period false readings are liable to be obtained owing to the catheter being plugged The diminution of urine obtained from the affected kidney is compensated by an increase from its fellow and this is generally of low specific gravity frequently slightly albuminous and may contain hyaline and granular casts

HEALING OF THE BLADDER

When the supply of infected material is cut short by nephrectomy the bladder tends to heal Often there is a quite dramatic relief of bladder symptoms within the first two or three days For a time however, the bladder remains hyperæmic though relatively free from deposit When the ureter has undergone much retraction this persists the trigone being permanently asymmetrical Puckers are sometimes observed on the vesical wall radiating from the situation of the ureter and indicating the distortion to which the viscus has been subjected Occasionally actual cicatrices may be seen on the vesical wall These follow patches of localized ulceration and present the weak appearance which is characteristic of healed tuberculosis elsewhere Sometimes healing may occur at one point whilst spread occurs at another a serpiginous ulcer resulting

Persistence of Bladder Symptoms —It has been said that bladder symptoms take as long to disappear after nephrectomy as they had persisted before operation This rough generalization is useful to keep in mind but is nevertheless inaccurate Where severe lesions have been present and bladder contraction has become well established a permanent reduction in its size will remain and is largely due to interstitial change in its wall Pyuria of vesical origin is also a frequent aftermath of the disease especially where secondary infection has grafted itself on to the tuberculous lesions Contraction and infection may perpetuate bladder symptoms

Another cause for vesical irritability is tuberculous ulceration unassociated with much surrounding cystitis. Heitz-Boyer destroyed such areas by what practically amounts to the high-frequency current ('l'étincelage'), taking in at the same time an area of surrounding tissue. After a period of reaction and sphacelation the membrane detaches itself and fresh epithelization is complete in about one month.

Patients who have been nephrectomized, and especially those who have a severe grade of cystitis, should be kept under observation in the Out-patients' Department so that the operative results may be known. When symptoms suggest that active disease is still present in the tract urography and cystoscopy should be advised so that the cause of failure to heal may be ascertained. The examination occasionally brings to light bladder lesions which are quite insignificant as compared with the symptoms which they are producing, and which may be amenable to treatment by diathermy. In two women patients, who after nephrectomy obtained complete relief, severe bladder symptoms returned in about 18 months. Cystoscopy showed a healthy urinary tract. The trouble was eventually traced to tuberculous disease of the uterus and adnexa and the symptoms disappeared after their removal.

PLATE V

A, Study of ulcerated calyx. Note lines of tubercles radiating to capsule and also subcapsular foci (cf. *Fig.* 74 a). B, Acute renal tuberculosis. Ulceration rapid. Pus was fluid and fœtid, indicating a mixed infection which accounted for the rapid, destructive process (cf. *Fig.* 74 c).

UROGRAPHY IN RENAL TUBERCULOSIS

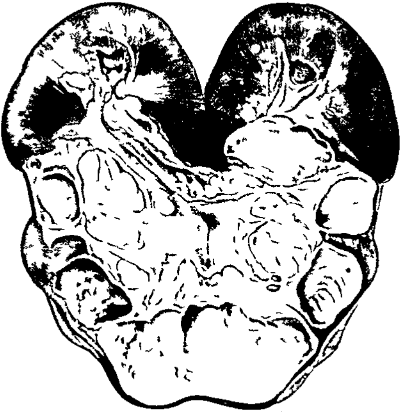
Ascending Urography.—This form of examination, when applied to the *tuberculous kidney* itself, has never had the full confidence of urologists. In the early days it was regarded as unsafe, but with increased care and a knowledge of its dangers it was in some measure re-instated. Now it is again falling increasingly into disuse owing to competition from descending urography, which almost invariably gives a firm lead as to the kidney affected and the extent of its disability. Where other guidance is clear retrograde pyelography will not be called into use, but it has a valuable field of application in those cases where an early focus is as yet untraced, because of its stronger shadows and more certain delineation.

The principal dangers of ascending urography are: (1) Catheterization of the ulcerated ureter may be followed by a reaction; (2) The ulcerated papillæ allow easy access of the urographic solution to the tubules (*see* also Chapter XXVI), and in some instances lines on the plate may be observed following the course of the tubules and radiating from the situation of the ulcer to the capsule (Papin points out that it is difficult to estimate the amount of pressure required,

PLATE I

RENAL TUBERCULOSIS

A



B D DAVISON

for the tuberculous kidney is not very sensitive to distension) (3) The trauma caused to a severely diseased organ would appear to be a ready method of disseminating organisms

The undesirability of retrograde pyelography for the "*healthy kidney*" has already been mentioned (page 127)

Excretion Urography has come prominently to the front in recent years because it is safer and simpler than the retrograde variety and

Fig 71 —Bilateral renal tuberculosis Excretion urogram The left kidney completely destroyed — functionless — no shadow Right kidney excavated Ureter and pelvis dilated and atonic The ureter appears to loop upwards near the ureteropelvic junction This does not really happen The appearance is produced by the silhouette of the ureter as it climbs forward on to the belly of the psoas muscle The margin of this muscle can be seen on the radiograph See *Fig* 73

Fig —Early left renal tuberculosis Excavation and dilatation of the upper and middle calices Excretion of quite good quality Note the good depth of shadow of the renal parenchyma on the left side also the ureteric atony and dilatation On the right side the pelvis and ureter are normal Observe the relatively narrow ureter Draining on the right side more rapid than on the left Therefore the shadows are weaker Intravenous urogram

so much less disturbing to the patient As before stated it should precede cystoscopy so that its findings may aid that investigation Immediately therefore a case is suspected of being one of urinary tuberculosis an intravenous pyelogram is arranged

Excretion urography is expected to yield data regarding which kidney is affected and should show the function of each kidney

The Diseased Kidney—This is revealed by changes in morphology (pelvic and ureteric) or in its function—probably in both

1 Changes in the *morphology* of the diseased organ and its ureter are responsible for modifications in the urographic shadow which are described below (page 134)

2 Changes in the *function* of the affected kidney Tuberculosis is usually well established in the urinary tract before it reveals itself, since the frequency of micturition which calls attention to it depends mainly on bladder involvement—a somewhat late event (*see* page 116) Some impairment of function will, therefore, have developed when the patient first comes under observation Weakness or delay

Fig. 73 —Contracted bladder from case shown in *Fig* 71 Note dilated atonic right ureter No ureteric shadow on left

in excretion will thus in early cases be discernible on the affected as compared with the healthy side, and it may amount to complete absence of shadow formation in more advanced cases (*Fig* 71—left kidney) Total failure of visualization is actually observed in more than one-third of all patients, and severe grades of functional defect in about another third Loss of renal function carries with it its own significance to which the surgeon will give due weight A great difference between the function of the two sides is more convincing than minor differences. If both sides have late and weak excretion, it is very inauspicious

At other times the shadow on the affected side is denser than that of the healthy kidney owing to the defective drainage of contrast fluid which follows the tuberculous invasion of pelvis and ureter This feature is illustrated in *Fig* 72, where, in addition to the good pelvic and ureteric shadows, the strong image of the renal parenchyma is worthy of remark

Advanced disease produces greater renal deformity, but at the same time greater disturbance of renal function. Change in the

uretero pelvic outlines may, therefore exist even when not portrayed because of weak excretion (*Fig* 71—left kidney) but in one or other or both of these ways the affected organ will almost invariably be detected

Ravasini and d'Agnolo have independently studied cases of urinary tuberculosis, both with the indigo carmine test and with excretion pyelography, and state that in this particular disease the results do not run parallel, which difference they attribute to the fact that uroselectan is excreted at the glomerulus and indigo carmine by the tubules

The Healthy Kidney—The important question next arises whether an early and copious excretion and a normal pelvic and ureteric outline (*Fig* 72—right kidney) may be accepted as proving the soundness of the supposed healthy kidney If so cystoscopy will be completely discarded with considerable advantage in some respects

On this matter there are at the present time various schools of thought Von Lichtenberg is responsible for the statement that excretion urography, the presence of the pathological bacillus in the urine and satisfactory blood retention tests are all the findings needed This attitude may be taken to represent one extreme, and that view which adheres firmly to a full cystoscopic routine the other Between these two extremes are to be found various shades of opinion There is no doubt that very small foci of tuberculosis can exist in a kidney without any recognizable alteration either of the renal function or of the pelvic contour Those surgeons who rely entirely on the pyelogram are willing to accept the risk that such a focus does exist and indeed they may be vindicated in so far as the lesion must of necessity be very small and in the light of modern research we know that many such foci disappear (page 107) Even after eighteen years of excretion urography the materials for deciding whether such a course is justified are not available A careful study of the long term behaviour of the remaining kidney is needed to determine which is the best method of judging its health To be worthy of the trust placed in it a pyelographic picture must appear early and with strong concentration Films, however good otherwise in which a calix is missing or indefinite or which are complicated by intestinal gas should be rejected as inadequate and a further set of films should be required There is much to be said in favour of adopting this plan when the cystoscopy is rendered particularly difficult in advanced bladder disease and the writer has done so on not a few occasions with almost invariably satisfactory results

Dealing next with the conservative school which practises something approaching a full classical routine cystoscopic overhaul the desirability of doing the absolute minimum of cystoscopic work

compatible with acquiring reliable guides to treatment has forced itself on our attention at many points in the foregoing discussion and cogent arguments against retrograde pyelography of either pelvis have also been advanced Probably those representing this conservative school are now a minority.

An intermediate course seems to the writer to be the most logical. Knowing the tuberculous nature of the trouble it accepts the urographic evidence of disease in the principally affected kidney

Fig 74 —Diagram to show (1) Several principal types of renal tuberculosis (2) The way they would be represented on ascending and descending urography (3) Six varying grades and types of ureteric tuberculosis The ureter in each instance is appropriate to the kind of renal lesion presented a is drawn from *Plate* V A, b from *Fig* 75 c from *Plate* V B and e from *Fig* 76

a Ulcero-cavernous type early (cf *Plate* V A) Erosion of one pyramid also a single deep-lying focus embedded in the parenchyma at the base of a pyramid and having no communication with the pelvis Middle and lower portions healthy On ascending urography would show erosion of the single pyramid and no other lesion

b, *Ulcero-cavernous type—disease more advanced (cf Fig 75)* Many large cavities in each pole which would be obvious with ascending urography

c Rapid and destructive lesion (cf *Plate* V B appearance of which is characteristic of mixed infection) Pus fluid and fœtid Cavities contain little caseous material and are very accessible to urographic media

d, Mixed lesion Tuberculous hydronephrosis above, ulcero-cavernous type below. Ascending urography—large cavities easily outlined above, eroded pyramids below

e, Mixed type (cf *Fig* 76) Two cavities which are entirely cut off from the pelvis and are filled with putty-like caseous debris Three empty cavities are seen which communicate with the pelvis and which are lined with tuberculous granulation tissue These would show with ascending urography if the ureter proved to be permeable Middle portion of the kidney converted into a fibro-fatty mass

f, Putty kidney (*rein mastic, Kittniere*) Masses of caseous material occupy the intervals between the columns of Bertini Ureter closed Ascending urography impossible Lime salts, representing a healing process, are present in greater or less degree in almost all such kidneys, which therefore throw good shadows on a radiograph The kind of picture shown in *Fig* 68 invariably indicates this type of the disease

Descending Pyelography —a Excretion good but a little retarded Erosion much less obvious than with ascending pyelography and might be overlooked b, Excretion later and weaker, cavities well displayed c and d, Excretion definitely delayed and feeble but contrast medium lodges in cavities and therefore throws good shadow e and f Functionless No excretion

Ureters —a No obvious anatomical change b, Moderate uretero pelvic dilatation c Ureter severely ulcerated and dilated Not thickened or contracted d Ureter dilated and thickened e, Thick walls with much peri-ureteritis Much ulceration of the mucosa Contraction taking place lower down Shortening marked f, Ureteric walls very thick, lumen filled with caseous debris above Complete obliteration of lumen occurs below the first inch or two

and gives due weight to the pyelogram of the other side Cystoscopy is not discarded. but the inspection is limited to a quick look round the bladder to ratify the previous indications and an indigo-carmine test to confirm the capacity of the presumed healthy kidney following which a catheter is passed up the ureter of the 'good' kidney. This catheter should be of ample size and should not it may be repeated, pass beyond the middle third of the ureter lest infection be carried to the kidney What is expected of this catheter is discussed on

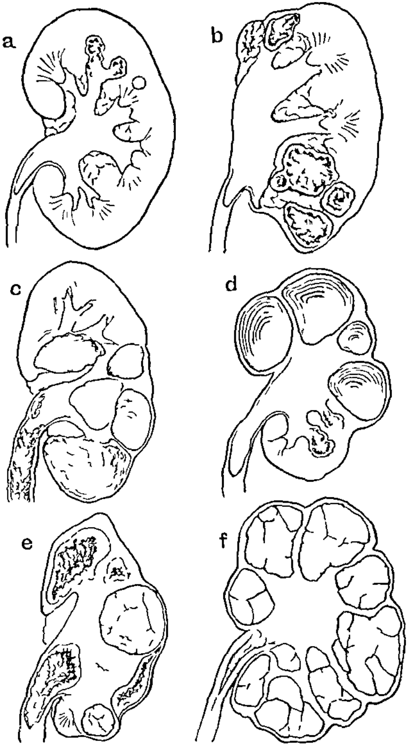


Fig 4

page 125 where the number of the pus cells in the urine is shown to be an important guide to the outlook for this kidney and where an attempt is made to appraise the significance of tubercle bacilli found in its urine.

As a supplement to what has already been said, it may be worth pointing out that a totally functionless and disorganized kidney is valueless as regards excretion and is a steady drain on the general health of the patient. It also keeps up a perpetual supply of infection to the bladder. So that, even if the second kidney is not

Fig. 75.—Renal tuberculosis, ulcero-cavernous type (cf. *Fig. 74*).

entirely above suspicion, there can be little to lose, and may be much to gain, by removing so grossly diseased an organ. In practice, however, nephrectomy will mostly be limited to those cases where there are genuine grounds for hoping that the remaining kidney will behave satisfactorily.

THE PYELOGRAPHIC PICTURE

The picture obtained will vary widely with the stage and type of the disease. There is no typical or characteristic picture. Having learned the nature of the complaint from preceding examinations we must interpret the film in the light of our knowledge of the anatomical types of the disease. I have attempted to illustrate

some of the most characteristic features of the disease in Fig 74 to which are related Figs 68 75 and 76 and *Plate V* These should

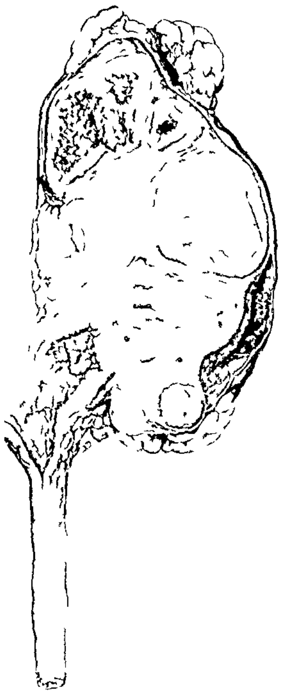


Fig 6 — Advanced and chronic renal tuberculosis Mixture of ulcero cavernous and putty varieties The central portion of the organ is converted into a fibro fatty mass Ureter and pelvis are thickened ulcerated pipe like and contracted (cf *Fig* 74 c)

be most carefully studied during the reading of the succeeding paragraphs

1 In the early stage only a minor inflammatory dilatation of the pelvis is observed

2 In the common ulcero-cavernous form the erosion of the papillæ will be outlined as single or multiple, rounded irregularities occupying the sites of the papillæ (*Fig* 77) These are generally more or less filled with purulent or putty-like debris, and the admixture of this with the solution gives an irregular moth-eaten margin to their shadow

Fig 77 —Renal tuberculosis Marked erosion of all calices Instrumental urogram

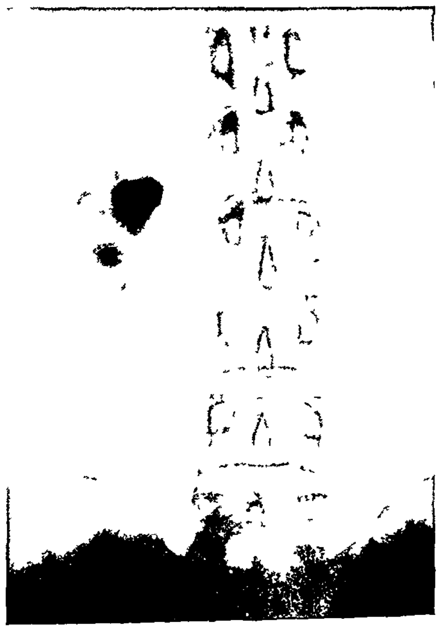


Fig 78 —Right renal tuberculosis Note the moth-eaten appearance presented by the ulcerated calices The ureter is dilated and atonic Instrumental urogram

(*Fig* 78) When the cavities are completely occupied by such debris access will be forbidden to the solution, so that they will not be outlined

3 The tuberculous abscess often develops deep in the parenchyma, and may communicate with the pelvis by a free opening or by a tortuous and narrow channel, or may be almost completely shut off The pyelographic picture will vary according to the freedom of access afforded to the solution, to the size and depth of the deformities, to the degree to which they are occupied by necrotic debris, and to their position and number

4 The *ureter* is invaded early in the disease and undergoes changes which produce characteristic and pronounced pictures on

urography At the period when tubercles are invading the musculature of the ureter the tube becomes atonic and the nodes and spindles of the healthy ureter disappear Dilatation of the ureter supervenes in many cases and the lumen seen radiographically may show several times its customary breadth Some of the most severe examples of inflammatory dilatation ever seen occur in tuberculous pyelo-ureteritis Dilatation is sometimes punctuated by strictures The resulting alternating contractures and dilatations (Fig 79) are coarse in their development constant in their position and can scarcely be confused

Fig 79.—Left renal tuberculosis Severe dilatation and excavation Cystoscopic urogram

with the delicate and ever changing variations in calibre seen in health When the ureter becomes strictured it may prove impossible to outline the pelvis at all—by instrumental urography because the fluid will not pass the stricture by excretion urography because the kidney is functionless In some cases the ureter above a stricture is choked with putty like debris which completely fills and obstructs not only the ureteric but also the renal cavities In these cases the kidney is completely destroyed and functionless its parenchyma being reduced to a shell (*see Fig* 74 f) The contents of this so called putty kidney are invariably impregnated with calcium salts which throw a good and distinctive shadow unmistakable for that of any other condition (*see Figs* 68 page 117, 235 page 391 and 238 page 394)

Perhaps the most constant late ureteric manifestation is that shortening which produces the well-known 'golf-hole' ureter. The shortened ureter takes the most direct course between the kidney and the bladder All the usual sinuous curves are replaced by a straightened shadow The absence of the wide sweep opposite the ischial spine is particularly striking, the ureter approaching the bladder almost vertically instead of swinging in with an ample curve *Fig* 80 is a tracing from an excretion urogram in a case of left renal tuberculosis The normal course of the right ureter can be seen, and

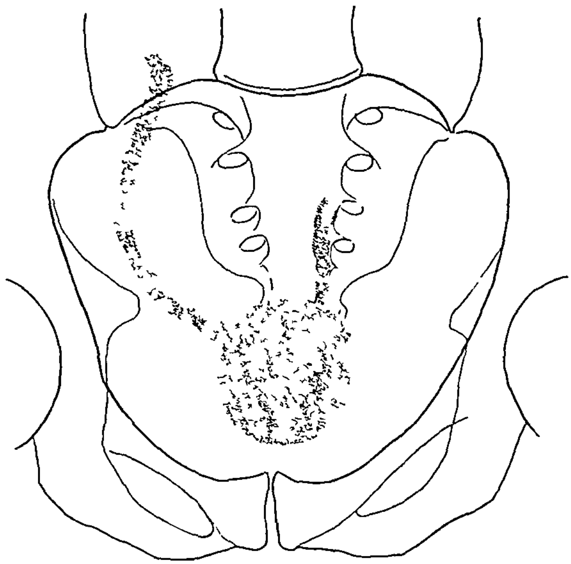


Fig 80.—Left renal tuberculosis Tracing from an intravenous urogram There was no secretion by the left kidney though the drawing shows opaque fluid in the left ureter This has regurgitated through an incompetent, diseased valve Compare the line of the healthy, right ureter with that of the diseased and shortened one The shape of this small bladder, which is quite different from that of a healthy bladder with a corresponding amount of contained fluid, denotes that it is pathologically reduced in size and that it is already filled to capacity

it approaches the bladder almost horizontally There was no excretion by the left kidney, but the bladder contained drug-laden fluid from the healthy kidney which regurgitated through the incompetent valve and displayed the altered course of the pipe-like terminal ureter The small capacity and modified shape of this bladder is likewise evident and instructive. The amount of fluid in this bladder is probably about 2 oz A healthy bladder containing only 2 oz would not have this globular shape It would be flattened from above downwards, the roof folding down close to the floor (*see Fig* 63, page 67, and *Fig* 67, page 90)

CHAPTER VIII

SYPHILIS OF THE BLADDER

THIS is a very rare condition In 1914 Levy Bing and Durœux reviewed the literature and showed that cases had never been recorded by any of the leading cystoscopists up to that time including Nitze, Finger Casper Frisch, and Zuckerkandl though undoubted examples had been observed by others This disease has however, received increasing attention in recent years

Historically syphilis of the bladder falls into three periods (Fowler) The first terminated in 1879 when Proksch discovered 6 cases which he considered authentic where subjects had come to necropsy with ulcers perforations or growths of the bladder which proved to be syphilitic in origin From that period until the end of the century a few cases were recorded where the diagnosis was made and symptoms disappeared under treatment The third period begins in 1900, when Matzenauer described the cystoscopic appearances of tertiary syphilis of the bladder for the first time Most of the recorded cases even to the present time have occurred during this stage probably because the severity of the symptoms draws attention to the vesical lesion whilst the secondary period is generally symptomless In 1909, however it was shown that the secondary period is not immune but only 9 cases had been reported up to 1918 Recently several urologists have undertaken routine cystoscopy on large numbers of syphilitics in both the secondary and tertiary stage and have found distinctive lesions associated with each period Prominent amongst these may be mentioned Chocholka, who investigated 705 cases and found lesions present in 32

Symptoms —These may be epitomized as follows —

The secondary period is generally quiescent but there may be ardor urinæ ' in a few cases especially when the lesions are situated near the vesical neck Bleeding is slight or absent In the tertiary period the symptoms are severe and often quite out of proportion to the cystoscopic findings Hæmaturia is the most constant manifestation it is usually terminal is sudden in onset and profuse but may suddenly subside Strangury and tenesmus are generally well marked

The *cystoscopic technique* is easy in the second stage but may be difficult or impossible in the tertiary owing to vesical irritability or to persistent hæmaturia

Cystoscopic Manifestations.—The cystoscopic appearances must be separately described for the secondary and the tertiary periods In some measure they resemble those found on other mucous membranes In the bladder syphilis retains its character as the great imitator Its aspects are very diverse and they may closely simulate the lesions of tuberculosis neoplasms, etc Chocholka says that it is the polymorphism of vesical syphilis which makes the disease appear to be so rare It is uncommon for it to present a picture which can be regarded as characteristic

SECONDARY PERIOD—In this there are two lesions—macules and ulcers *Macules* consist of areas of deep-red engorgement, generally superimposed on an already hyperæmic mucosa They are occasionally elevated (papules) From 1 to 3 or 4 mm in diameter, they elect to overlie the terminals of small arterioles In due course they suppurate and break down Multiple foci coalesce to form ulcers *Ulcers* are as a rule multiple and quite small, rarely reaching the size of a threepenny piece As many as a dozen have been observed Their site of election is the bladder base, and especially the ureteric and interureteric region but they may be found elsewhere Though generally clustered together, they may be widely disseminated When situated near the vesical outlet they give rise to symptoms suggesting cystitis They are rounded or oval, but their margin is often irregular, slightly elevated and may be thin or infiltrated The base may be covered with a whitish slough, or may be exposed and red The ulcers are usually surrounded by an area of hyperæmia and œdema

TERTIARY PERIOD—The tertiary lesions are more often encountered and show greater variety, four principal types may be described (1) Œdema, (2) Gummata, (3) Gummatous ulceration, (4) Papillomata (false)

1 *Swelling* of the vesical wall is fairly common and it often takes the form of thick coarse, cerebriform folds which are very vascular and may be red or violet-coloured They may be found in various situations and in one instance were confined to the upper half of the bladder (Nilsson)

2 *Gummata* occur as spherical elevations of yellowish colour, and show a preference for the ureteric area They are surrounded by a narrow ring of hyperæmia and undergo ulceration Necrosis appears, in fact to be an early event and the stage of true unulcerated gummata is only occasionally seen According to Israel, symptoms do not arise till ulceration has taken place

3 *Ulcers* may be single but as many as three have been noted They are rounded or oval and may attain the size of a sixpence Their edges are jagged infiltrated and may be considerably elevated The base is usually whitish or grey in colour and contains the typical

adherent wash leather slough It bleeds if touched Irregularities of the floor from which blood constantly oozes have been described Around the ulcer is an area of engorgement and oedema in which sinuous blood vessels are unusually evident Perforation into other hollow organs with the formation of fistulæ occasionally occurs (Uya Thruster Wyeth etc)

4 *Papillomata* (*false*) are very rare (Levy Bing) but were found on four occasions by Chocholka They may be quite indistinguishable from the true villous neoplasm except in so far as they yield to anti syphilitic remedies They are usually smooth in surface implanted directly on the mucous membrane and are reddish or reddish grey in colour They may be multiple and do not exceed a monkey nut in size Their appearance sometimes closely simulates that of a villus covered carcinoma which has undergone ulceration These various tertiary lesions may coexist and are often superimposed on one another (Asch)

Diagnosis —The diagnosis is made by the finding of (1) Marked ulceration etc in the absence of tubercle bacilli (2) A positive Wassermann and other syphilitic evidences and (3) Speedy recovery under antisyphilitic treatment when other remedies have proved unavailing In practically all the cases recorded improvement under antisyphilitic treatment was remarkably rapid and complete Hæmaturia generally subsides after a few days and eventually all lesions vanish except where fistula formation has occurred

Cystoscopic Manifestations.—The cystoscopic appearances must be separately described for the secondary and the tertiary periods. In some measure they resemble those found on other mucous membranes. In the bladder syphilis retains its character as the great imitator. Its aspects are very diverse and they may closely simulate the lesions of tuberculosis, neoplasms, etc. Chocholka says that it is the polymorphism of vesical syphilis which makes the disease appear to be so rare. It is uncommon for it to present a picture which can be regarded as characteristic.

SECONDARY PERIOD.—In this there are two lesions—macules and ulcers. *Macules* consist of areas of deep-red engorgement, generally superimposed on an already hyperæmic mucosa. They are occasionally elevated (papules). From 1 to 3 or 4 mm. in diameter, they elect to overlie the terminals of small arterioles. In due course they suppurate and break down. Multiple foci coalesce to form ulcers. *Ulcers* are, as a rule, multiple and quite small, rarely reaching the size of a threepenny piece. As many as a dozen have been observed. Their site of election is the bladder base, and especially the ureteric and interureteric region, but they may be found elsewhere. Though generally clustered together, they may be widely disseminated. When situated near the vesical outlet they give rise to symptoms suggesting cystitis. They are rounded or oval, but their margin is often irregular, slightly elevated, and may be thin or infiltrated. The base may be covered with a whitish slough, or may be exposed and red. The ulcers are usually surrounded by an area of hyperæmia and œdema.

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4. *Papillomata (false)* are very rare (Levy, Bing), but were found on four occasions by Chocholka. They may be quite indistinguishable from the true villous neoplasm, except in so far as they yield to anti-syphilitic remedies. They are usually smooth in surface, implanted directly on the mucous membrane, and are reddish or reddish grey in colour. They may be multiple and do not exceed a monkey nut in size. Their appearance sometimes closely simulates that of a villus-covered carcinoma which has undergone ulceration. These various tertiary lesions may coexist, and are often superimposed on one another (Asch).

Diagnosis.—The diagnosis is made by the finding of: (1) Marked ulceration, etc., in the absence of tubercle bacilli; (2) A positive Wassermann and other syphilitic evidences; and (3) Speedy recovery under antisyphilitic treatment when other remedies have proved unavailing. In practically all the cases recorded improvement under antisyphilitic treatment was remarkably rapid and complete. Hæmaturia generally subsides after a few days, and eventually all lesions vanish, except where fistula formation has occurred.

CHAPTER IX

BILHARZIASIS OF THE BLADDER

Bilharziasis (also called schistosomiasis) is due to a trematode or fluke, *Schistosoma hæmatobium*, and is a disease which is only seen in this country when soldiers or others who have been infected abroad return home After the second world war, during which our nationals have been stationed in all parts of the world, it is almost certain that occasional patients suffering from this disease will present themselves at home for diagnosis and treatment There are three main varieties of bilharzial disease (1) *B hæmatobia*, which attacks the genito-urinary apparatus, (2) *B mansoni*, which principally affects the intestine but is found in the urinary organs in 4 per cent of cases, (3) *B japonica*, which has a wide distribution in Eastern Asia, causing lesions in the intestine and cirrhosis of the liver This chapter concerns itself only with the first-mentioned—*B hæmatobia*

Bilharziasis is endemic in many tropical countries, but Egypt is conspicuous as the principal focus The geographical distribution of the disease in that country is, however, unequal The irrigation areas round the lower reaches of the Nile are probably the most severely infected places in the world In one village Leiper found that 90 per cent of the children were infected, ova being present in the urine It is computed that at least half the population is affected Ferguson, in a long series of necropsies, found bilharziasis in more than 60 per cent In women the disease is much less prevalent than in men, probably because the men are exposed to attack by the parasite when at their work, the majority of patients being agricultural labourers "When the female bladder is attacked by bilharzia it is usually very severely affected and almost hopeless to relieve" (Madden) The building of the large Nile dams has had the unfortunate consequence of increasing the incidence of the disease by making irrigation continuous instead of intermittent, as previously, and thus extending the period of operation and widening the distribution of the intermediate host (a snail—*see* later) Figures showing the extent of the infection amongst young people are supplied by K Bey, who, out of a total of 124 children of school age, found 97 infected, and by Wildt, who discovered 110 out of 120 medical students to be infected

Bilharziasis is also endemic in most of the remainder of Africa, though here, too, its intensity is variable In the region of Mombasa

Kirkaldy Willis says that at a conservative estimate 90 per cent of the natives have been or are infected. Madagascar, Arabia, Iraq, Iran, Palestine, Syria, Cyprus and the southern shores of Greece, some areas of South America, and certain parts of China and Japan are also affected in varying degrees.

The life history of the trematode which is responsible for the disease was worked out by the War Office Expedition under Leiper in 1915. That Commission showed that the parasite has an asexual and a sexual phase. The former takes place in the liver of a mollusc (*planorbis*) where sporocysts and daughter sporocysts develop. Either of these can give rise to cercariæ—larval structures which the mollusc discharges into the stagnant water of ponds, canals, etc. Cercariæ are capable of movement by means of a bifid tail and attach themselves to any available mammal, human or other (definitive host). Passing through the unbroken skin, they reach the liver of the host, there to develop and differentiate into male and female adult worms (sexual phase). These together migrate against the blood stream of the mesenteric vein to the vesical and ureteric radicles. The route of transference of the worm from the portal to the systemic circulation has hitherto been unknown, but now Makar has demonstrated anastomoses on the right side between the radicles of the ureter and the cæcal tributaries of the superior mesenteric vein, and on the left side between *the ureteric radicles and the inferior mesenteric vein*. *The female lays* eggs in clumps under the bladder and ureteric mucosa. When these customary channels become blocked, eggs are laid in adjacent parts, as for instance below the mucosa of the prostatic urethra. The vesical clumps constitute the specific lesions as seen through the cystoscope. Rupturing into the vesical cavity, the eggs are discharged with the urine. They do not, however, hatch out in urine, the osmotic pressure being unsuitable, but if they reach fresh warm water, that fluid penetrates the capsule, distends and ruptures it, releasing a miracidium. Miracidia are motile bodies which seek out a suitable mollusc (planorbis) and recommence the life cycle above described. The discovery of the ova and motile miracidia in the urine of a patient establishes the diagnosis.

Cystoscopic Manifestations.—When the ova are laid in the submucosa they cause small areas of œdema and hyperæmia, together with petechiæ of the overlying mucous membrane, and these non-specific lesions are the *earliest* cystoscopic findings. As the egg clumps approach the surface they become visible beneath the mucosa. The appearance is shown in *Plate VI E*, page 152. Small bright whitish or pale yellow objects of rounded or oval form and elevating the mucosa are seen scattered irregularly over the bladder surface or clustered together in groups. The above mentioned area of hyperæmia persists around them and throws them into relief. Bullous

œdema is often seen at the stage of invasion and also at a later time. At both periods it may be severe. At certain places ill-defined irregularities (superficial ulcers) of the mucosa indicate the spot at which ova have ruptured into the cavity. There may or may not be a ring of surrounding inflammation. Owing to the situation occupied by the adult worms the ova predominate around the ureteric orifices, though any part of the bladder, including the fundus and anterior wall, may be involved.

The appearance of this early lesion is characteristic, and once seen is not likely to be mistaken. There are only two conditions with which it can be confounded. One is the early tuberculous bladder. The masses of ova, which are often spoken of as tubercles or pseudo-tubercles, are larger, brighter, more numerous, and more disseminated than are true tubercles. To the uninitiated the ova might suggest the minute purulent spots observed in cystitis, described on page 87; the latter are irregular in size and shape, more granular, duller, surrounded by more diffuse vesical hyperæmia, and can be removed by persistent irrigation. Ova or miracidia found in the urine ratify the diagnosis.

At a *later* time (*Plate VI* F) the normal vesical mucosa is replaced by irregular areas of reddened mucous membrane from which numerous ova have escaped, leaving a red, ragged surface, comparable with that of granulation tissue. Other parts of the mucosa are paler than usual and over large areas there may be no trace of any blood-vessel (Makar). Calcification of the eggs as they lie in the submucous plane and of their surroundings, is common, localized areas of the bladder becoming flecked with gritty and sometimes brilliant particles which produce an appearance like sandpaper—the so-called ‘sandy patches’. Calcification is actually seen quite early in the disease and is an important and specific lesion, but with the passage of time it increases in extent and is largely responsible for:—

1. The pale areas of mucosa just mentioned;
2. Inelasticity and non-contractibility of the bladder wall in advanced cases;
3. Forming a barricade past which ova cannot escape into the bladder cavity—hence the paucity of miracidia in the urine in the late stages of the disease;
4. X-ray shadows, which will be described later.

Agglomerations of bilharzial eggs and granulation tissue cohere to form the bilharzial ‘node’, a structure whose appearance has been suitably compared with that of a mushroom, which it resembles in its brownish colour and often in its shape. Bilharzial nodes, however, are not infrequently red or purplish in colour, and resemble a cock’s comb, a likeness which has often been remarked. So long as the

disease is active recently laid eggs are to be seen "Often the surface is studded with softening pseudo tubercles which contrasting with the surrounding hyperæmia give a strawberry appearance Nodules may become aggregated together to form the so called bilharzial masses (H Milnes Walker)

Cystitis—Sooner or later the bladder becomes infected and all the lesions of cystitis are engrafted upon those of bilharziasis The cystitis may conform to any of the types discussed in Chapter X It

Fig 81—Well marked submucosal calcification of the bladder in bilharziasis An Egyptian aged 35 seven years pain in right loin and pelvis a poor stream (*Major Phys Je ss s case*)

may be mild but is often of great severity and the whole wall thickened and contracted, may be lined with phosphate covered papillomata bilharzial tissue and degenerating masses of stinking debris Cystoscopy under such circumstances is impossible Vesical fibrosis (*Fig* 81) results in inelasticity and defective contractility of the bladder wall which is further aggravated by varying grades of calcification in the submucous planes as already described Kirkaldy Willis however says "a bladder which can be felt per abdomen as a hard mass is in my opinion always carcinomatous and never merely a fibrosed and hypertrophied bilharzial bladder

Calculi—Stones are present in about 50 per cent of cases When examined the stones may be found to have formed around a nucleus of bilharzial ova (Looss and Ruffer) which were probably lying originally

in a broken piece of bilharzial papilloma (Madden) The majority of stones met with in Egypt have a nucleus of uric acid or oxalate of lime, and are originally begun in an acid urine In 100 operation cases 60 contained phosphates, but only 10 were pure phosphatic

Fig 82 —Vertical section through a bladder infected 30 years previously during the South African war The bladder was the size of a large coco nut The thickened walls consist largely of fibro-fatty tissue The cavity of the bladder is almost obliterated by bilharzial and papillomatous tissue A transverse septum appears to separate an upper and a lower cavity

stones (Madden) In course of time sepsis supervenes and the original nucleus is coated often deeply by phosphates

New Growths—Papillomata occur late and often attain a large size As a rule they have none of the delicacy of the non bilharzial papilloma being for the most part squat and covered with stunted villi They are firm in consistency and deep red in colour Masses of polypoid inflammatory tissue also will very commonly be observed and may closely simulate a true papilloma Carcinoma is a common lesion and presumably results from long continued irritation It closely resembles the types of cancer seen apart from bilharzial disease, the papilliferous variety being the most common (*Fig* 82) Sarcoma is not very rare Afifi states that approximately 20 per cent of vesical bilharziasis cases ultimately develop tumours which are usually papillomas and carcinomas but are sometimes sarcomas Amongst 40 malignant bilharzial tumours Ferguson found 34 carcinomas and 6 sarcomas Tumours arise at an earlier age than is customary with most malignancies Ogier Ward says that of 130 cases of carcinoma of the bladder 22 occurred in patients under 30 years and 57 in patients between 30 and 40 years Sorour found a bladder cancer of bilharzial origin in a boy of 15

Ureteral Bilharziasis—As amongst the principal sites of egg laying are the peri ureteric parts of the bladder it is not surprising to find that the terminal few centimetres of the ureter are frequently involved in the bilharzial process ova being actually deposited in the ureteric submucosa The higher reaches of the ureter are unaffected except in advanced cases as they lie beyond the part occupied by the parasite The small bore of the ureter is quickly reduced by the addition of this foreign material and by the œdema which it excites At a later stage sclerosis accentuates and perpetuates the obstruction and all the customary changes in the proximal urinary organs follow When the tract is aseptic simple dilatation ensues but sepsis is common and results in pyelonephritis and pyonephrosis If treatment is effective in destroying the parasite ureteral obstruction may disappear when the distension of the upper passages tends to recover Yet in many patients as Ogier Ward says the obstruction is continued by the sclerotic process in the vesical wall surrounding the ureter In such cases the bladder mucosa is pale and avascular and the ureteric orifices are rigid and lifeless Radiography will then show calcification of the terminal ureter (*Fig* 83) and an excretion urogram will show dilatation of greater or less measure That author thinks that if a dilator can be introduced through a panendoscope the stricture is more amenable than any other type of ureteric stricture and he quotes Goldschmidt who has only thrice found it necessary to open the bladder in order to treat resistant strictures

When ova are discovered in the urine and the bladder itself is proved to be healthy by cystoscopy the ova must necessarily come either from the ureter or from the urethra. In the former case ureteric catheterization will give rise to undue bleeding and suggest the position of origin: alternatively, an intravenous pyelogram may show some grade of dilatation. At a later time hydronephrosis and obstruction to the passage of a catheter will occur, but by this time vesical changes are sure to have made their appearance.

FIG. 88.—Bilharziasis of bladder and ureters with calcification. ([illegible] case.)

Value of Cystoscopy in Bilharziasis.—Cystoscopy plays an important role in the handling of bilharziasis:—

a. In those not infrequent early cases where the ova cannot be seen in the urine it demonstrates the presence of the disease and is the surest means of diagnosis. Regarding the later stages, Campbell Begg says, "ova are so seldom seen in the urine in cases of chronic bilharzia that their absence has no diagnostic significance. The only really reliable method of diagnosing the disease is by cystoscopy". Vermooten says that in his experience patients usually come for treatment eight to ten years after the original infestation. "Rarely are any ova present in the urine and the eosinophilia, if any be present, rarely amounts to more than 2 per cent. The diagnosis can therefore only be established by cystoscopic examination."

b. If the presence of ova or miracidia has already shown the existence of bilharzial infection cystoscopy will determine its extent, distribution, and type. When a neoplasm is found cystoscopy provides a guide to the correct line of action. It is a good thing to make a map of the lesions observed for future reference, and to sketch in on this map such things as ulcers, sandy patches, papillomata, and other lesions, showing their situation, size, etc.

c Two or three weeks after a course of treatment with tartar emetic fouadin or other selected drug cystoscopy is again resorted to to find out what results have been obtained It may show partial or complete resolution of pathological processes Cystoscopy is a much safer standard by which to test cure than the absence of ova from the urine the latter being notoriously fallacious Again, many polypoid masses which were suspect as being possibly cancerous will have diminished or vanished under treatment The response demonstrates their purely granulomatous nature

d Operative cystoscopy may be called for to fulgurize benign papillomata to obtain biopsy material (especially to differentiate between true tumours and polypoid inflammatory tissue) and to dilate strictures of the ureter

Other Complications—Fistula formation to the surface especially to the perineum, or to other organs is not uncommon The sclerosing changes which accompany such fistulae and the urethral strictures which are common in the later stages of the disease may hamper cystoscopy or even make it impossible In men the prostate and seminal vesicles are often infected and may suppurate In women all the generative organs are liable to involvement in inflammatory or neoplastic lesions

Radiography should be employed routinely A *plain radiograph* may show —

a The presence of calculous disease together with its extent

b Shadows thrown by sandy patches in the bladder These areas of calcification are seen in many plates and as they lie in the submucous layer of the bladder, they may show thin circular or ring like shadows (*Fig* 81)

c Similar calcifications in the lower ureter which are occasionally recognizable (*Fig* 83)

Excretion urography should be used to display the condition of the upper urinary tree As ureteral sclerosis is usually the result of involvement of the terminal ureter the earliest radiological evidence is dilatation of the section immediately above this and a short length of widening and tortuosity with a normal superjacent ureter is characteristic As the contraction becomes more pronounced the dilatation spreads upwards and eventually involves the pelvis The grade of pyelectasis and of widening and tortuosity of the ureter may eventually be severe The addition of sepsis tends to increase it If treatment is effective in destroying the parasite ureteral obstruction may disappear and with it the distension of the upper passages tends to recovery

CHAPTER X

TRABECULATION AND DIVERTICULA

TRABECULATION

THE normal bladder mucosa is smooth and even. An odd muscle bundle may elevate its surface here and there. but in general it is regular and flat. If the organ is over-distended. or for any other reason the patient experiences an urgent desire to micturate. a few bands may rise on the wall but they are transitory. some appearing as others disappear. Under a number of conditions these muscular ridges become more evident. and the bladder is then said to be trabeculated.

1. Trabeculation due to Hypertrophy.—Hypertrophy resulting from obstruction is the chief cause and the best examples are seen in prostatic enlargement and urethral stricture. It follows that trabeculation is more common in men than in women. In the latter. however. it is often well marked. the two principal aetiological factors being cystocele and obstruction by fibroids. The more muscular habit of the male predisposes to the greater development of fleshy bands.

2. Idiopathic Trabeculation.—Occasionally trabeculation is found apart from obstruction or other disease and appears to be idiopathic. It is more common in elderly people. though it may be met with in the young. In the latter it is usually found in subjects of inferior physique. and both in them and in the old is possibly due to scarcity of intermuscular tissue more than to hypertrophy of muscle. It is therefore apparent rather than real.

3. Diseases of the Central Nervous System.—Trabeculation occurs in certain diseases of the central nervous system. but. as it then presents special characteristics it will be dealt with separately (page 151).

Cystoscopic Appearances.—The following account relates particularly to trabeculation seen in hypertrophied organs. The appearance of the idiopathic variety is similar to the slighter manifestations here described. The absence of obstruction will of itself distinguish the two classes.

In the early stage the meshwork is comparatively simple. A few muscle bands course here and there. widely separated by unaffected areas. Intersections are few and minor bundles are not observed. Close inspection will generally reveal some fine graining of the slips

due to isolation of individual muscular strands. As the hypertrophy advances the reticulation becomes closer and stronger. The original bundles increase in breadth and height and numerous secondary ones spring up between them. All of them intermix inextricably, forming a complicated lattice-work (Fig. 84). The bands divide and subdivide and between them are to be seen the recesses known as false diverticula. The rounded prominence of the ridge catches the full force of the lamplight and is brightly lit whilst the intervening crypts are thrown into shade. The more prominent the elevation, the deeper the shadow in the recess.

Fig. 84.—Vesical hypertrophy. Trabeculae of varying development and false diverticula.

Blood vessels run their normal course in the submucous tissue irrespective of the development of the bundles which they may be seen to accompany or cross. Perhaps they are more numerous than those of the normal bladder as these obstructed organs are usually somewhat hyperaemic. When cystitis occurs, of course, blood vessels increase markedly in number and size and the vesical mucosa is frequently thickened, red and velvety. The ridges then look coarser, their finer features are lost and the crest of the muscle bands takes on a rounded and swollen appearance.

Position.—Trabeculation concerns only the detrusor; the trigone and ureteric bars are not affected. In the earliest stages it is confined to the lower segments of the muscle—the retrotrigonal area and the lateral recesses. As it increases it extends to the sides and eventually to the summit of the viscus. But as it spreads further afield its development in the lowest area progresses and it is invariably better marked here than above. Though the ureteric bar is not itself involved, the nearness of so many crypts and depressions may hinder the discovery of the ureteric orifices.

Cystography.—With suitable media cystography (*see* page 157) will show up these false or intramural diverticula if they are well developed, the bladder shadow appearing to be irregular or indented (Grape bladder, *Traubenblase*) (Fig. 85).

TRABECULATION OCCURRING IN DISEASE OF THE CENTRAL NERVOUS SYSTEM

Nitze was the first to observe trabeculation in tabes dorsalis. It is now known that whilst most characteristic in that variety of

nervous disease. it is also seen in others—for instance, in atony from postero-lateral sclerosis and from spina bifida (Thomson-Walker) This author examined 31 cases of tabes in its earlier and irregular forms According to him "trabeculation is generally present, but was occasionally absent . The muscle ridges are fine and evenly set, and the branching is regular and orderly Very fine twigs can frequently be seen branching and interlacing. A solitary muscle band may stand up sharply for two or three inches on the bladder wall The interspaces are not so deep and are saucer-shaped The side walls and apex are affected, while the trigone escapes" He held that 'the earliest change in these cases is atrophy, and that the prominence of some muscle bundles is largely due to atrophy of neighbouring bundles'

PLATE VI

A, Trabeculation of the bladder of moderate degree Muscular bundles of various sizes run in different directions and occasionally cross one another Fine graining of the slips can be seen The intervening recesses form false diverticula The course of blood-vessels bears no relation to that of the muscular slips Note bright illumination of edges of bundles B, Orifices of two true diverticula Bladder wall healthy but trabeculated Muscular bundles radiate from the neighbourhood of the diverticula A ring of muscle surrounds and supports the margin of each orifice Blood-vessels pass over the margin into the recess Depths of sac are generally quite black C, Varix of bladder D, Fistula of the upper wall of the bladder secondary to carcinoma of the colon Pus entered the bladder intermittently as depicted, especially when suprapubic pressure was exerted Note the severe cystitis, œdema bullosum, and the air-bubble E, Early bilharziasis The white objects are groups of submucous ova on a hyperæmic base In the lower section of the picture the ova have escaped into the bladder cavity, but the hyperæmic patch still remains F, Bilharziasis of medium severity Lesions as in E, but in upper section a raw area simulating granulation tissue is observed, from which many ova have been shed

This type of trabeculation is distinctive and can be recognized immediately by those who know it It is frequently present before other signs of locomotor ataxia have developed, and several times I have made the diagnosis by the vesical appearance Trabeculation occurring in an unobstructed bladder requires further investigation, and the Wassermann test should be taken and the cerebrospinal fluid examined

Another important pathological change visible by cystoscopy and suggesting nervous disease is an alteration of the bladder neck resulting in its becoming funnel-shaped It is described in Chapter XVII

FALSE DIVERTICULA

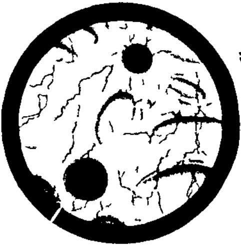
False diverticula are the counterpart of trabeculation and hypertrophy Between the muscle bundles are fossæ or recesses whose shape is determined by that of the adjacent bars Their mouths are open and may be triangular or rhomboidal circular or oval Their depth is proportionate to the development of their boundaries, but

PLATE II

MISCELLANEOUS BLADDER CONDITIONS

celala

A



Diverti
culae

B

x

C

Visico
Colic
Fistu

D

E

F

is never great Usually it can be explored cystoscopically It may be thrown into deep shadow unless the lamp is held directly opposite the orifice In contrast with true diverticula (*see* later) in which the walls diverge to form flask shaped cavities it is the rule for the boundaries of these crypts to converge like inverted cones False diverticula are invariably multiple, and are often numerous Their distribution corresponds to that of the trabecula

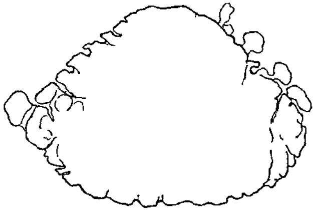


Fig 85 —Cystogram of much trabeculated bladder (Grape bladder *Traubenblase*) Note the greater development laterally than above The diverticula of the fundus are not seen in this view

TRUE DIVERTICULA

In a true diverticulum a portion of mucous membrane continuous with that of the bladder is projected through the vesical wall and forms a flask shaped sac outside that cavity but communicating with it by a narrow neck (*Fig* 86) Whether the condition is of congenital or acquired origin is a vexed question One thing however is certain —that it grows as a result of increased intravesical pressure This pressure is transmitted through the opening and the walls of the diverticulum practically unsupported by muscular tissue stretch dragging at the same time from the interior of the bladder fresh supplies of mucosa pretty much in the same way as an inguinal hernia increases its size at the expense of the abdominal peritoneum

Diverticula are often observed in routine cystoscopic investigations They are much more numerous than was believed before cystoscopies became so common They are often encountered unexpectedly and may or may not be responsible for the patient's symptoms They can be diagnosed only by the cystoscope though they may be suspected when excentrically placed or hour glass shaped shadows are found radiographically in the pelvis or where micturition in two parts is observed Both phenomena are exceptional Diverticula are commonest in obstructed bladders especially therefore in

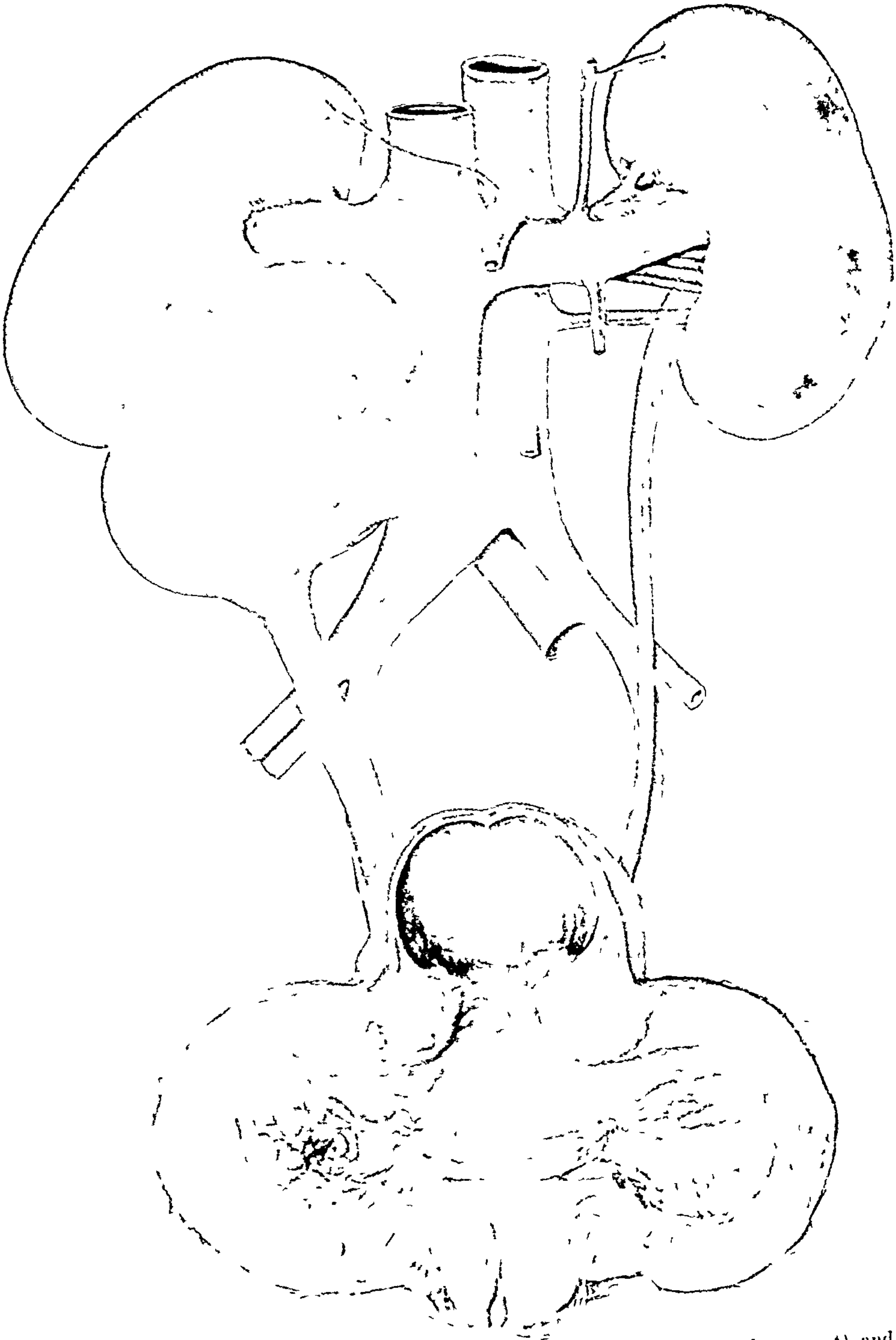


Fig 86 —Diverticulum of bladder Bladder, urethra (note prostatic enlargement), and diverticulum laid open anteriorly Mucosa thickened and inflamed Marked vesical hypertrophy Powerful sphincter surrounds opening of diverticulum Compare thickness of sac with that of bladder Sac is adherent to right ureter which is dilated Right pelvis is also markedly dilated Note that the pelvis is adherent to the vena cava and that the right spermatic vessels traverse the adhesions An accessory vessel runs to the upper pole of each kidney The patient died of uræmia, both kidneys being severely infected

elderly men but a few cases occur in women (14 per cent Judd 12 females in 205 cases Hinman 101 females in 2919 collected diverticula Kutzmann) and they have been seen in children and young adults Durrieux (1901) collected 195 vesical diverticula 13 occurred in children below 10 years of age and in 2 instances the diverticula were found in a fœtus

Cystoscopic Appearances —The cystoscopic appearance is that of a hole cleanly punched out of the bladder wall (*Plate II* B) It is generally rounded but may be slit shaped and this latter appearance is occasionally due to its being viewed obliquely Its orifice is small usually of about such a size as would admit a lead pencil and rarely

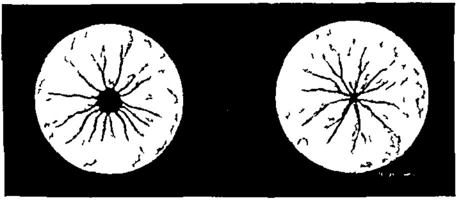


Fig 87 —Cystoscopic appearance of diverticulum open and closed demonstrating sphincteric action of orifice (*Hyman*)

appearing larger than a threepenny piece Unless very shallow its depths are quite black and unilluminated A firm muscular ring appears to support the edge of the ostium and through it disappears the mucosa The surrounding mucosa may be smooth but often shows trabecula and false diverticula Occasionally the muscle bands take origin and radiate from the ring like the spokes of a wheel This trabeculation is usually limited to the neighbourhood of the opening though it may be generalized when there is the customary urinary obstruction As the mucosa escapes through the orifice it shows on its vesical aspect one or more pleats or folds which suggest that it has been dragged into the opening Vessels may be seen ramifying on the margin and passing into the pouch Occasionally an ostium has been seen to exhibit sphincter like action (*Fig* 87) Buerger has illustrated a diverticulum which contained a papilloma but was sometimes seen shut I have examined a bladder and noted a diverticulum which at a subsequent cystoscopy was not to be discovered

Situation —The situation of choice for diverticula is the region surrounding the ureter and its bar (*Fig* 88) For this reason some

regard them as accessory ureteric buds which fail to reach the developing kidney They may, however, occasionally open on any other part of the viscus and are sometimes seen in the apex In this position they are generally small and multiple A single large pouch in this area is usually of different origin being a remnant of the urachus Sometimes the orifice appears to lie relatively high on the posterior wall and gives the impression that the diverticulum will be easily reached at operation These sacs, however, are quite often found to droop down between the trigone and the rectum and are very inaccessible

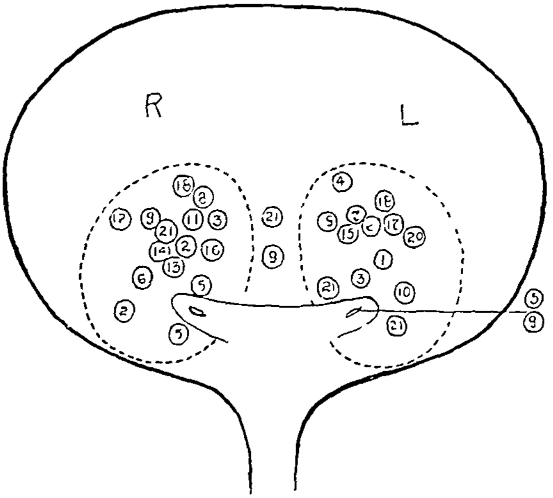


Fig 88 —*Graphic representation of the relative position of diverticular orifices in 21 cases* Cases Nos 2, 3, 5, 6, 9, 18, and 21 have multiple diverticula The only instances in which the base was involved are in two of these (9 and 21) A ureter opened into *a diverticulum in only two instances, and again both* were cases (5 and 9) with multiple sacs (*Hinman*)

When the opening occupies the usual situation the sac as it increases may drag on the ureter so that the latter gradually approaches the margin and, together with its ridge is eventually swallowed by the pouch It follows that the ureter may be found near the opening on its very edge, or may not be discernible at all Diverticula occurring in the neighbourhood of the ureteric orifice are liable to drag on it, and so cause obstruction Hydro-ureter and hydronephrosis (*Fig* 86) will result, and if infection is added, pyelonephritis and pyonephrosis Diverticula arising quite close up to a ureter have, as a rule, an earlier and a greater effect on the upper tract than those placed further away

Number —Diverticula may be single or several may be present They rarely exceed six or seven in number When multiple they may be symmetrically disposed around the two ureteric orifices In 17 cases Hinman found 11 single diverticula and 6 multiple Of the latter there were two openings in four cases, and three and four each in one Multiplicity appears to vary inversely with the size Large ones are usually single (Negro and Blanc)

The Size of the Sac —This cannot be estimated by cystoscopy, though in a few instances it has been possible to introduce the beak of the instrument through the aperture (*Fig* 89) (Meyer) Such an operation should be easier in the female on account of the shortness

of the urethra but diverticula are very uncommon in that sex. To introduce the extremity of the instrument into the *orifice in the male* would necessitate a longer shaft and lens system than the usual *one and the size of the orifice might* prevent its entry.

Cystography must be called in to show the size of the pouch. Lerche (1911) was the first to suggest the taking of a radiograph with the viscus filled with an opaque solution. A preliminary radiograph shows whether there is any stone. As contrast media collargol, bismuth and argentos were formerly used, but sodium bromide or iodide (10 per cent) or iodoxyl are now employed. Silver iodide (5 per cent emulsion) is also popular as it throws an excellent shadow, is a good antiseptic and is non-irritating. In an attempt to empty the diverticulum the patient should first be rolled over on to his face for a short time and then instructed to urinate. The vesical cavity is now distended with solution until the patient feels it to be full, when the catheter is clamped and left in situ. An exposure will show the vesical shadow together with that of the pouch (*Figs.* 90–92). The bladder silhouette may by its broken outline show evidence of false trabeculation (page 152 and *Fig.* 91). In many instances

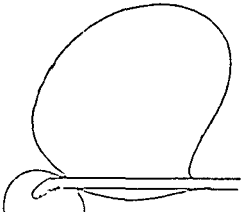


Fig. 89.—Cystoscopic examination of the interior of a diverticulum.

it overlaps and hides the shadow of the diverticulum. With the patient still recumbent the catheter is now unclamped and the bladder contents flow out. The diverticula usually occupying a dependent position and being non-contractile still retain their solution, and a *fresh radiograph will show their outline uncomplicated by that of the* bladder (*Fig.* 92). An interesting contrast cystogram can be obtained by distending the vesical cavity with air and a lateral exposure is frequently helpful. In these ways the size, shape and number of diverticula in the usual situation may be demonstrated. Those in the apex of the organ require the position of the patient to be reversed. The bladder is subsequently washed out to avoid irritation.

Sometimes whilst taking cystograms it happens that the patient strains to urinate and the diverticulum shadow may then be seen to grow at the expense of the bladder fluid, transference taking place from one to the other.

Fig 90—Cystogram of diverticulum of the bladder Demarcation between the two cavities is easily seen and the difference between the depths of fluid in them accounts for the dissimilar density of the two shadows Margin of bladder irregular contrasting with that of the diverticulum

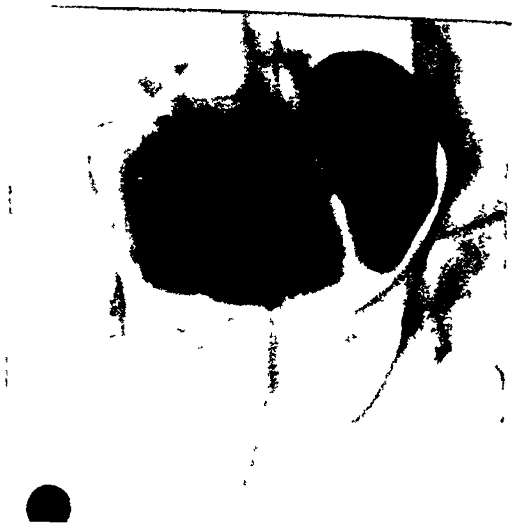
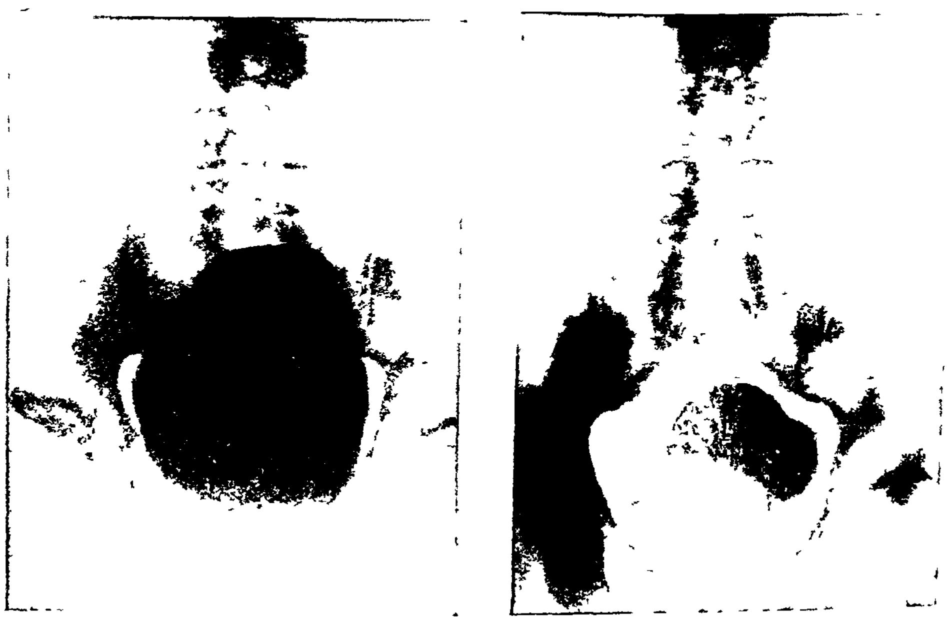


Fig 91—Cystogram of a large diverticulum of the bladder The narrow neck is well seen and is of the almost invariable size The distance separating the shadows of the diverticulum and the bladder gives an idea of the thickness of the bladder wall Hypertrophy is also shown by the irregular bladder outline Compare with the smooth contour of the diverticulum



A B

Fig 92—A Diverticulum of the bladder filled with contrast medium B The bladder has been emptied by catheter with the patient prone The fluid remains in the diverticulum Whether or not solution is retained in a diverticulum depends on the position of the orifice

Another but I think less satisfactory method of demonstrating the size of these cavities is recommended by Gilbert Thomas A shadow casting bougie is paid into the cavity with the aid of a catheterizing cystoscope and is allowed to coil itself up inside the pouch (Fig 93) If instead of a bougie, a ureteric catheter is used the diverticulum can be filled through it with opaque solution

The capacity of these sacs varies widely They may be as small as a pea or large enough to hold a gallon of fluid (Green, quoted by

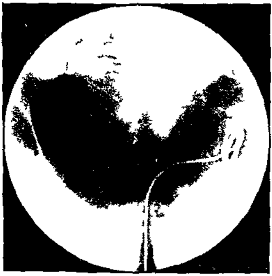


Fig 93 — Shadow casting bougie paid into cavity of diverticulum where it has curled itself up (Gilbert Thomas)

Targett) The diverticulum which is met with in routine work does not often exceed the size of a tangerine orange but exceptional instances are on record of a diverticulum being much larger than the bladder and it is then easy to mistake the bladder for the diverticulum and vice versa both on the cystogram and at operation

The size of the opening bears no relation to that of the diverticulum An opening which will barely admit a crow quill may yet open into a sac capable of containing a pint or more of fluid The demonstration of a diverticulum may be accomplished by cystography when cystoscopy is impossible owing to a small irritable, or displaced bladder

Complications —Complications are frequent and may be considered under the following headings —

Obstruction — Some type of obstruction (urethral prostatic nervous etc) is present in a high proportion of cases many writers asserting that it is always to be found if carefully looked for At the prostatic age diverticula are said to exist in 5 to 7 per cent of

When diverticula occur in children they are very liable to be associated with stone. Englisch (1904) collected 171 cases of vesical

Fig 96 —' Dumb-bell ' stone of diverticulum

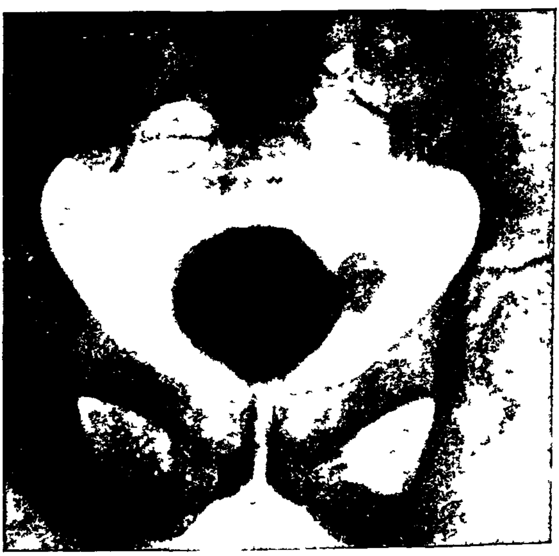


Fig 97 —Cystogram of stone shown in *Fig* 96

diverticula in which calculi were found associated Of these, 22 occurred in children under 10 years of age the youngest being an infant 8 days old

Calculi impacted in the sac have been liberated by incising the wall with diathermy cystoscopically (Walther). This method of treatment will only be feasible when both the stone and orifice are small. The technique is similar to that employed in freeing a stone from the lower end of a ureter (page 355; *see also* page 224).

As a rule the diverticulum as well as the stone requires removal or there will be recurrence. The approach is made by the extraperitoneal mobilization of the bladder, followed by the isolation and excision of the sac (*Fig.* 98). The intravesical prominence of the

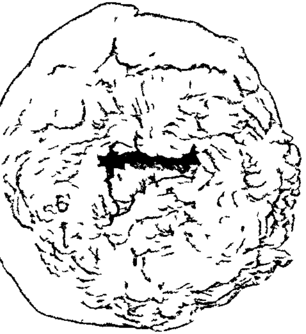


Fig. 98.—Diverticulum of the bladder. Operation specimen with orifice *facing*. Ragged area surrounding orifice is the section glued to the bladder. Remainder is smooth walled. (*Natural size*.)

stone shown in *Figs.* 96, 97 had on two occasions been removed and twice recurred before excision of the sac led to a cure.

On two occasions the writer has had to treat very numerous stones impacted in false diverticula of unusual depth, the surrounding trabeculæ being so strongly developed as almost completely to close the opening and very effectively to conceal the stones, which were extracted with considerable difficulty.

Growths.—Tumours quite frequently occupy the interior of a sac or its edge, or occur in the bladder associated with a diverticulum. They may be papilloma, carcinoma, or more rarely other growths. In a series of 133 cases treated at the Mayo Clinic, Judd and Scholl found carcinoma in the diverticulum in 4, and in the bladder associated with the diverticulum in 6. Thomson Walker reported 3 carcinomata

in 1910. Buerger has illustrated one in which a diverticulum containing a papilloma had an orifice which was observed to close Satellite splashes were present in the bladder itself. In several cases in the author's practice papillomata have arisen within a diverticulum one of which is illustrated in *Fig* 110. page 190. and another in *Plate VII* c

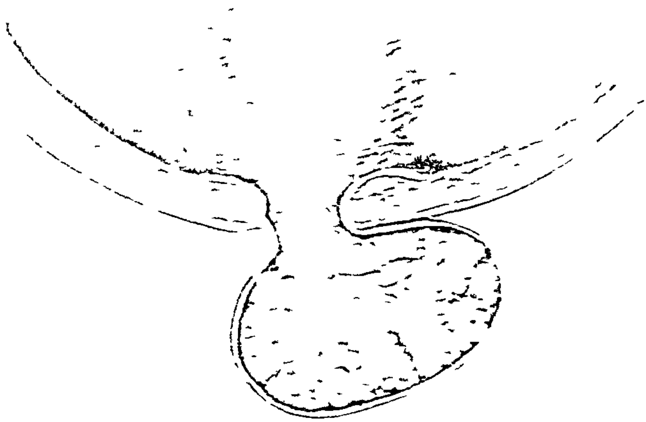


Fig 99 —Papilloma growing from a diverticulum Its intravesical component hides its site of origin

page 172 *Fig* 99 shows how it fungated into the bladder completely precluding all possibility of recognizing its site of origin till the superficies had been destroyed by diathermy Amongst rarer growths the following may be noted . Targett found a sarcoma and von Blum an angioma in a diverticulum

Complications arising in the upper urinary tract have been referred to above (page 156).

CHAPTER XI

TUMOURS OF THE BLADDER

THE SIGNIFICANCE OF SYMPTOMLESS HÆMATURIA AND THE NECESSITY FOR ITS EARLY CYSTOSCOPIC INVESTIGATION*

'SYMPTOMLESS HÆMATURIA' is a term used to cover all cases in which hæmorrhage occurs from the urinary tract unassociated with any other symptom or sign such, for instance, as pain, urgent or frequent micturition, or a lump. Such unaccompanied bleeding is quite common and may be the result of a variety of pathological processes. Indeed, there are few of the many diseases of the urinary tract which do not sometimes give rise to hæmorrhage, though with some of them bleeding is characteristic, whilst with others it is exceptional. If the vascularity of the organs concerned is considered, this will not seem surprising. The kidney in particular is an organ of exceptional vascularity, and that portion of the bladder which is most susceptible to disease—namely, the base—is also rich in blood vessels. Yet though so many lesions may cause hæmaturia, in practice it will be found that unaccompanied bleeding is very suggestive of a urinary neoplasm. Indeed, there is a well-known dictum which states that 'symptomless hæmaturia indicates a growth of the urinary tract,' and it is with this probability in his mind that the surgeon will approach the investigation in any given case. That he will frequently find himself mistaken may be shown by reference to four cases of symptomless bleeding which occurred in my own practice recently, and which on investigation proved to be: (1) A case of scurvy rickets; (2) A case of early renal tuberculosis; (3) One of that unsatisfactory group of cases classified under the title of 'essential renal hæmaturia'; (4) Stone impacted in the pelvic outlet, in which, though the patient denied any history of pain, the parenchyma had been markedly encroached upon by back pressure. Many other causes might also be recalled, but in a large proportion of patients with symptomless hæmaturia a neoplasm of the urinary tract will be found. Walther, in a study of 74 cases of hæmaturia both accompanied and unaccompanied by other symptoms, demonstrated

* A lecture delivered at the Salford Royal Hospital to a post-graduate class contained the material which is embodied in this section. It was published in the *Brit. Med. J.*, 1921, April 30, and is reprinted here by kind permission.

that over 50 per cent were the result of urinary growths, and that of these 72 per cent were malignant. If his article had referred only to cases of symptomless hæmaturia, the percentage of growths would have been much higher.

Two matters require investigation in all cases: (1) The anatomical point from which hæmorrhage originates: (2) The nature of the pathological processes giving rise to it

Of these the former is a matter of urgency. The latter can be dealt with at leisure, but it must be ascertained at the earliest possible moment whether the bleeding is from the upper or from the lower urinary tract and in the first alternative from which side it is coming. This last is the important thing A growth in the bladder may be seen when the hæmorrhage has disappeared, but bleeding from the upper tract must be located during an attack, for then the bloody efflux from one ureteral orifice can be seen (*Plate XIV* A page 368: *see also* page 367) and the corresponding kidney or ureter held culpable Further in all cases which are 'symptomless' there is only one real guide, and that is the cystoscope. There is no pain: there is no lump Some doubtful information may be obtained from the presence of blood well mixed with the urine, which is generally held to come from the kidney: or from the presence of worm-like clots which have received their shape from the ureter: but these are uncertain guides and even they will not determine which side is bleeding If he waits until there are other symptoms to guide him the surgeon runs the risk that the case will become inoperable: yet such procrastination happens frequently. Hinman on an analysis of the published work of eight different surgeons found that in 709 cases of renal growths hæmaturia was the onset symptom in 42 per cent, but that when the cases came to operation only 6 6 per cent showed hæmaturia unaccompanied either by pain or tumour, and he justly remarks that this "indicates the lost opportunity in making an early diagnosis".

Any one of the tumours of the urinary tract is capable of causing symptomless hæmaturia and more commonly than not they announce themselves in this manner. In order to keep the argument clear I will limit myself to two of the commonest tumours of the tract—namely, papilloma of the bladder and hypernephroma of the kidney These happen also to be two varieties which consistently give rise to symptomless bleeding: the former, according to Hurry Fenwick showing this as its first symptom in 84 per cent of cases whilst Israel states that the latter heralds itself thus in 70 per cent

There is considerable variation in the period of their life-history at which they give rise to hæmorrhage: in some cases we find that the first bleeding comes from a growth, papilloma or hypernephroma, which from its size must have been growing unsuspected for a long

time but in many cases it is quite early, when the growth is small Such a hæmorrhage coming from a small growth whether of the

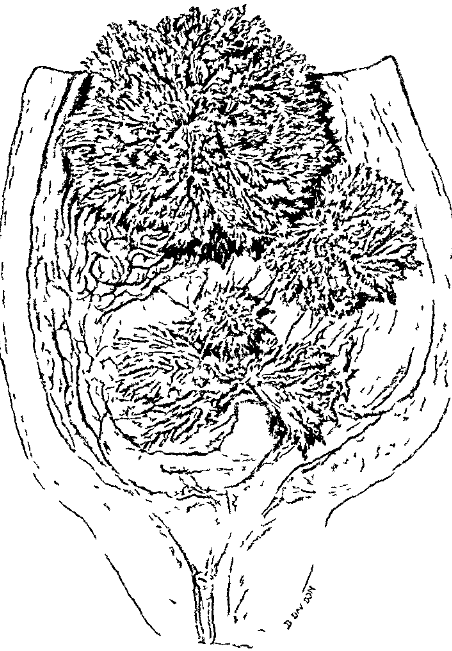


Fig. 100.—Multiple papillomata. Villi beautifully developed. Patient exsanguinated on admission and died immediately.

bladder or kidney may not be repeated before months or occasionally even years have elapsed the growth in the meantime having become well nigh untreatable Surely this gives an uncanny importance to

that single manifestation, and throws a grave responsibility on the medical practitioner to see that it is not allowed to subside without having been traced to its source. Generally the duration of that preliminary hæmorrhage is short, it is often only a few days or even hours, so that the diagnosis of its anatomical origin is a matter of urgency. Denaclara states that in 146 cases of renal neoplasm only once did the primary hæmaturia last as long as fourteen days.

Each of these two types of tumour runs a peculiar and almost invariable course, in that each at first is benign, but eventually undergoes malignant transformation. The papilloma in the early stage is single, has a long slender pedicle, and does not invade submucous planes. Later it becomes multiple, subsessile, or sessile, tends to invade and disseminate, and eventually destroys life by anæmia and cachexia. Singularly enough, the hypernephroma also is at first a benign growth. It is encapsuled and grows slowly. It may exist in this condition for many years—cases have been reported up to twenty years—behaving in the same way as do parotid tumours. Later it also takes on malignant changes, growing more rapidly, invading its capsule and the renal vein, and disseminating. It is remarkable that two growths in the same tract should share this somewhat rare characteristic, but it only emphasizes the importance of prompt diagnosis, for in the early stage the treatment of each is that of a non-malignant neoplasm, is easy and satisfactory, whilst ultimately the growth becomes malignant and the prognosis unfavourable. Nature, as it were, holds out to us the option of successful treatment, if we are but discerning enough to recognize her signals, but she will just as capriciously snatch away the proffered chance if we do not seize and secure it, and the sole intimation of impending disaster which she vouchsafes is that preliminary hæmorrhage which is often so transitory. *Figs.* 100 and 101 show large neglected vesical papillomata, each of which proved fatal.

To recapitulate, it has been shown that hæmaturia is frequently the only symptom of a growth of the urinary tract, that following this expression of its presence it may retire into absolute quiescence for a long period, during which it is increasing in size and probably advancing towards malignancy, that when it reasserts itself whether by a second hæmorrhage, pain, dysuria, or the presence of a lump it may have passed beyond the operable stage, and that if the growth should prove to be of the upper urinary tract, the only time at which a diagnosis of the anatomical site can be made is during the period of actual bleeding.

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* Renal function tests and a pyelogram may, however, be suggestive of change in one or other kidney (*see* Chapters XXIV, XXV and XXVII).

Hæmaturia is, therefore, not a symptom to be treated *per se*. It is a red danger sign urgently demanding an accurate diagnosis—(1) As regards its anatomical point of origin, and (2) As regards its pathological cause. It is an easy thing to put a patient suffering from acute abdominal pain to bed and give a hypodermic injection of morphine. Such a course will be followed by relief of the pain,

Fig 101.—Extensive papillomatosis of the bladder. Patient was admitted with retention and died of uræmia. Stagnation and infection on each side of the upper tract.

but the profession has long ago learnt the hazard of this procedure so long as any doubt remains in regard to the diagnosis. Similarly it is an easy matter to put a man suffering from hæmaturia to bed and administer certain reputed hæmostatics. Such a course may be rewarded by a cessation of the hæmaturia, and the medical attendant will have the gratitude of his patient, but surely on contemplation must have the mortification of realizing that he has done him a great disservice. It is much better to keep the patient

in active life, and to perpetuate the hæmorrhage rather than to allay it, until such time as a cystoscopic examination can be arranged and the source of the bleeding accurately located.

Instances of such misguided treatment are unfortunately only too frequent in practice. I will cite a single case. A man had had a short sharp hæmorrhage from the bladder three years previously for which he had been treated by his medical attendant, with cessation of the bleeding. From this point onwards symptoms were absent until he began to suffer from vesical discomfort and the sensation of incomplete emptying of the bladder. Cystoscopy revealed a growth of such large dimensions that examination was difficult owing to the instrument plunging amongst the fronds of a papilloma, which, on account of its size, had to be removed by suprapubic cystotomy, and when this was done a pair of smaller 'kiss-cancers' was revealed on the opposite bladder wall. If this patient had undergone cystoscopy three years previously, his condition would have been treated rapidly and easily by diathermy, and the open operation would have been avoided.

As the growth gets older the attacks of hæmaturia become more prolonged, severe, and frequent. On occasion I have had to examine patients who have had continuous hæmaturia for weeks, a few of these suffering from severe anæmia. In one instance a medical attendant told me that he had attempted to knock off portions of a growth by introducing a metal instrument and twisting it about in the bladder—a practice which is condoned in text-books belonging to a past generation, but which must obviously be condemned in view of the possibility of ocular demonstration by modern methods.

These are the grosser errors, but I have nevertheless been much impressed by the frequency with which hæmaturia is palliated with resultant danger to the patient. If the best results are to be obtained, the cases must come up at the first onset of symptoms. Other urologists experience the same trouble. Braasch in an analysis of a series of 83 cases of hypernephroma of the kidney found that on an average hæmaturia had existed for more than a year in 77 per cent before their symptoms precipitated treatment.

As a matter of fact, the profession is frequently not responsible for the delay, for patients often cannot be brought to realize the importance of the condition so long as it is unaccompanied by pain or discomfort. The complacency with which patients, particularly amongst the uneducated classes, regard such hæmaturia is astonishing, and on occasion considerable pressure is needed to secure a full examination of the urinary tract because they could not understand the importance of the condition. Bransford Lewis records the case of a man suffering from a hypernephroma of the kidney who carried about with him for six years a letter from his medical man

to a consultant in spite of the fact that blood was present in the urine all the time Similar instances could be multiplied though the duration in this case was extreme

I have laid emphasis on the responsibility of the medical attendant because of the importance of an early cystoscopic examination Had symptomless hæmaturia been as common as the acute appendix it would have gone through the same phase as that condition experienced many years ago and would now be invariably submitted to immediate cystoscopy just as the acute abdomen is promptly opened

THE EXAMINATION OF VESICAL NEOPLASMS

INDICATIONS FOR CYSTOSCOPY

The discovery of a vesical neoplasm is invariably made with the cystoscope It cannot be made otherwise apart from open exploratory operation In 84 per cent of villous growths (Fenwick) *hæmaturia* is the first indication of disease The importance of immediate investigation in symptomless hæmaturia has already been explained The remaining tumours (16 per cent) give rise to *pain* which may be renal vesical penile perineal or the pain of obstruction and in all cases save perhaps a few neglected ones the cystoscope is essential to its elucidation

Having discovered a neoplasm the endoscopic investigation must further ascertain (1) Its type (2) Evidences of malignancy, (3) Its size (4) Its position (5) The number of growths (6) Concomitant bladder lesions, (7) Whether primarily of intra or extra vesical origin (8) Indications for treatment

Everything indeed that can be learned about tumours of the bladder it is the office of the cystoscope to disclose In large part also modern treatment devolves upon it as will be shown later Nowhere is cystoscopy more serviceable

CONDITIONS COMPLICATING TECHNIQUE

The preparation of an uninfected viscus containing a small growth presents no particular difficulty, but much resourcefulness on the part of the surgeon may be necessitated by (1) *Tumours of large size* (2) *Hæmorrhage* (3) *Cystitis*

1 Tumours of Large Size—The way in which large growths interfere with cystoscopy is discussed later (pages 182–185)

2 Hæmorrhage—Cystoscopy should if possible be undertaken whilst the bleeding is still active in order that should it prove to originate in the upper tract its source may be located Whilst it is as a rule possible to clear the bladder sufficiently to permit at least a provisional diagnosis active hæmorrhage is occasionally so

persistent, or the organ is so filled with clots which cover its base and discolour its contents, that no progress is achieved. In spite of these occasional failures the rule still holds that cystoscopy should be attempted during the hæmorrhage. In one case in the author's experience where clots arising from a papilloma filled the bladder, cystoscopy had to be postponed for a fortnight. At the end of this time the clots had formed into the two rounded blood stones shown in *Plate VII A*. They eventually acquired a phosphatic crust and were crushed by the cystoscopic rongeur and evacuated.

The hæmorrhage for which one is consulted is often excessive, and I have known many instances in which it became necessary to transfuse before proceeding. When severe, intravesical coagulation is liable to happen, and the attempts of the bladder to pass its clots precipitate hæmorrhage afresh. In these circumstances the method of using paraffin for the vesical medium may be given a trial (*see* page 55): otherwise relief should be obtained by suprapubic operation. A Bigelow's evacuator to remove clots, and the perurethral

PLATE VII

A. Two blood stones resulting from profuse hæmorrhage from the vesical papilloma of which a portion is seen. B. Close view of a portion of a papilloma occurring in an infected bladder; the villi are swollen and there is some phosphatic deposit on their surface. C. Papilloma originating in a diverticulum as seen after one treatment with diathermy; prior to the first treatment the diverticulum was occupied by that portion of the papilloma which bulged into the bladder (*see Fig.* [illegible], *page* 164). D. Multiple papillomata. The primary growth is in the [illegible]. E. Papilloma originating in a ureter and fungating into the bladder. F. A growth near left ureter.

cautery to seal the bleeding point, have been recommended, but are risky, as the growth may be damaged, and they frequently fail.

Hæmorrhage is sometimes started by injury during vesical lavage. This results from :—

a. Bruising of the papilloma by the beak of the instrument. The usual position of the growth is the area facing the vesical outlet and in this position it is exposed to damage by movements of the catheter during lavage. Where a bladder growth is suspected the instrument should be introduced so far that its eye lies just within the internal meatus, and should be maintained there steadily. Movement, particularly that of propulsion, may bruise the growth and cause hæmorrhage. Note therefore the point occupied by the cystoscope when fluid first escapes from the bladder, and retain the instrument in this position (*see Fig.* 46, *page* 49). It is easier to do this in the male than in the female, for the instrument is more firmly supported by the urethra of the former.

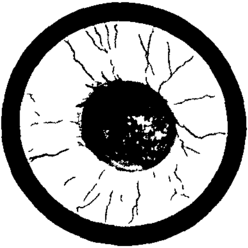
b. Avulsion.—Occasionally a piece of the growth gets drawn into the eye of the catheter during evacuation of the bladder and the

PLATE VII

BENIGN TUMOURS OF THE BLADDER

A

B



C

D

E

F

return flow stops suddenly When the instrument is withdrawn to discover the cause a piece of the growth is forcibly detached The resulting hæmorrhage may be free and uncontrollable The possibility of such an accident should be remembered if the stream suddenly stops and instead of withdrawing the catheter the injection of more lotion should first be tried in the hope that it may disengage the growth Naturally large papillomata are more likely to be trapped than small ones As the growth is usually implanted on the inferior segment of the bladder the fenestra should always face the pubes during evacuation

Hæmorrhage may be combated by the methods described in Chapter III but if a view of the growth can be obtained in spite of continued hæmorrhage the application of an electrode to the bleeding point may be effective in controlling it

3 **Cystitis** —This condition is a frequent attendant on bladder growths It is more often associated with malignant than with simple ones and is especially partial to the nodular type It is a serious complication for such a bladder shares with that of vesical tuberculosis when secondarily infected the unhappy distinction of hampering cystoscopy more than any other combination of lesions The bladder is small, intensely irritable, and easily bleeds and the difficulties it imposes may prove insuperable Gentleness patience and the ability to use the cystoscope in a small space may be required As a rule it is useless to ward these patients in the hope of gaining amelioration in the cystitis by internal and local medication for the condition is very intractable and usually shows little improvement

Cystitis of mild degree is also found with benign growths, and may be a sequel to diathermy as will be shown later but it is generally less severe and more amenable to treatment Severe cystitis must be regarded as suggestive of malignancy and the susceptibility of a bladder thereto and also its reaction to treatment are to be taken into account when estimating a growth s malignancy The liability to infection must be recognized and every endeavour put forth to maintain asepsis during cystoscopy

Tumours of the bladder may be of *connective tissue or epithelial origin*

TUMOURS OF CONNECTIVE TISSUE ORIGIN

Tumours of connective tissue origin are very rare Fibroma myoma fibromyoma myxoma chondroma angioma and sarcoma have been recorded *Plate VII F* shows a capillary nævus which arose in the neighbourhood of the left ureter In 1930 (*Brit J Surg* **18** 205) I reported this case and one other and I collected from the literature 20 additional cases The growths are therefore

rare They give rise to profuse and recurrent hæmaturia which led four times in the 20 collected cases to death from exsanguination They may be small, capillary in type, and obviously superficial, as is the one illustrated, when they are suitable for perurethral diathermy but they may also take the form of cavernous nævi involving the muscular coats, and must then be submitted to partial excision Diathermy would merely precipitate hæmorrhage and in one instance actually proved fatal (Katz) Nævi in other parts of the body have been observed in a large proportion of cases

TUMOURS OF EPITHELIAL ORIGIN

Tumours of epithelial origin fall into three main categories (I) *Villous papilloma*—(*a*) *Benign* (*b*) *Malignant*, (II) *Nodular* (*malignant*) *growth*, and (III) *Endometrioma* (*see* page 213)

I. VILLOUS PAPILLOMA

All simple villous growths eventually undergo malignant transformation, and it may therefore be argued that there is no such thing as a benign papilloma The classification and nomenclature are however convenient and will be retained here The two groups of papillomata will be described together, as it is thought best to regard them as different manifestations of the same process, bearing in mind, however, the fact that the degree of malignancy is more marked in some instances than in others, and that at corresponding ages two growths of similar appearance may behave differently, both clinically and in their reaction to treatment Many villous tumours are definitely malignant from their commencement

Life-history of a Papilloma.—The earliest stage of the primary growth is never seen cystoscopically as it causes no symptoms However its appearance can be surmised from that of the minute secondaries to which the parent growth gives origin and which are often observed It is that of a tiny red elevated spot the size say of a pin-head and when slightly older it shows a tufted crown foretelling its subsequent villiform appearance On reaching the dimensions of a small pea it will be discovered to have developed a pedicle, which relatively to the size of the papilloma is of considerable length From the main trunk numerous subsidiary offshoots emerge, clothed with an exuberance of crinkled epithelium After a certain stage growth affects mainly the superstructure so that the pedicle becomes relatively shorter Still later it becomes stouter and stockier until eventually it approximates in girth to that of the main tumour mass The tumour has therefore passed through three phases in which it has been successively pedunculated, subsessile and sessile, and with each stage it approaches more closely to malignancy

The mobility of the pedicle on its site of implantation cannot be tested cystoscopically (see however page 184) but it is known that at first the mucosa from which it springs is freely movable over its subjacent coats that in the second stage more resistance and stiffness are encountered whilst in the third invasion by epithelial elements is present or at any rate imminent The growth is now frankly malignant and though glandular involvement is a late feature with all bladder tumours the prognosis is altered A similar change affects the villi whose previously long slender processes lose their fragility and to some extent their mobility and eventually assume a coarser and more swollen appearance

Papillomata are frequently multiple (*see Plate VII* D and *Figs* 100 101) Cells detached by trauma or by contact with other parts of the bladder will engraft themselves and produce secondary splashes This may occur early in the course of the disease but is more usual when the parent tumour has reached the size say of a marble or rather more and the bladder as it contracts down is becoming capable of compressing the growth and dislodging tumour cells Satellite growths may occur close to the site of the original tumour or at a distance They may be single or there may be several and in rare instances I have seen a bladder so profusely splashed with small sessile buds as to resemble the rash of measles This condition has been styled a diffuse papillomatosis The secondary tumours undergo an evolution similar to that of the original growth with this exception that pedicle formation is not so marked in the early period and malignancy must therefore be regarded as less remote

It may be seen therefore that it is rational to regard a benign and a malignant villus covered tumour as one and the same at different points in its life history and that the simple tumour though in the early stages an easy victim to destruction is nevertheless potentially an infiltrating cancer The age at which these growths become actually malignant varies considerably a few taking a decade or more whilst some require but a few months On the average however, they need about two to four years I have seen several in which hæmaturia had occurred for more than ten years and the growth was still suitable for diathermy In most of these the position of implantation was higher than usual on the bladder wall Such a slow evolution is uncommon

The *nature* of a growth may be judged by its cystoscopic appearance or by the pathological investigation of a piece of tumour removed by the cystoscopic rongeur (*Fig* 102) The appearance of a villous growth will be described first and the question of acquiring pathological material will then be discussed

Benign Villous Papilloma.—Of all the objects observed in the bladder there is none which can compare in elegance with a papilloma This is particularly true of the smaller growths, which consist of beautiful irregular masses of delicate tendrils clustered together eddying to and fro with every movement of the vesical contents and recalling the appearance of a sea anemone When of larger development they lose in a measure their delicacy and comeliness

From what has been said above regarding the evolution of a papilloma it will be gathered that the same growth seen at different stages in its development, will present varying characters When still small the villi will be luxuriant fine in texture, and comparatively long. Various growths however show this quality in varying degrees

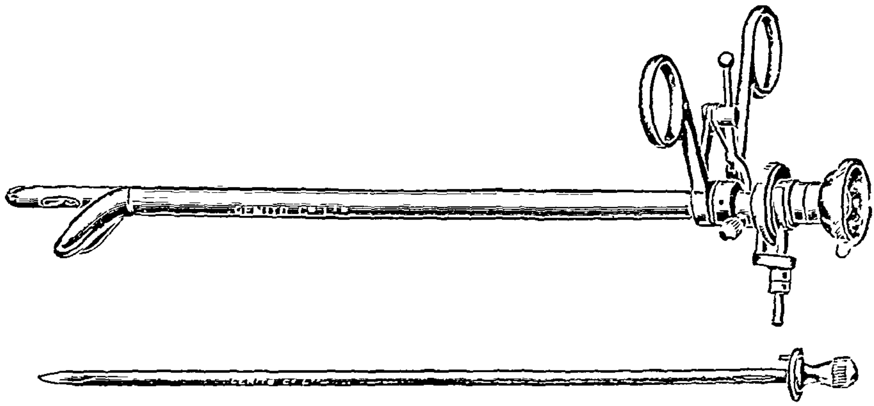


Fig 102 —Cystoscopic rongeur

In some the villi are of unusual length and have then been likened to sea-wrack grass In others they are club-shaped, squat, and regular, and the general appearance recalls somewhat the surface of a raspberry The above varieties, however, and especially the former, are rare, and the usual condition, accounting probably for 90 per cent of all cases is the intermediate one represented in *Plate X* A, page 202 As the tumour grows its villi are actually or relatively reduced in length and though even in old and extensive growths they are usually evident, in a few they are so much reduced that the surface may be likened to that of a fine marine sponge

The colour of the papilloma, owing to its vascularity is slightly more ruddy than that of the bladder wall Occasionally it has a purplish tinge When the light catches the edge of a villus it imparts lustre to it whilst if a villus intervenes between the lamp and prism it appears translucent This happens frequently when a large growth that occupies much bladder space is being examined Occasionally a silvery-looking growth is met with, the appearance resulting from necrosis or from phosphatic deposit in sepsis

A single blood vessel occupies each villus and may be seen by direct inspection or still better under transmitted illumination. Several hypertrophied vessels may also be observed coursing in the vesical mucosa towards the base of the papilloma to supply it with blood. When infiltration has occurred at the base a certain amount of thickening, and occasionally some bullous œdema (*Plate VIII* E, page 180) may be noted in the surrounding mucosa. A very similar appearance occurs after diathermy, and the two must not be confounded, as their significance is entirely different (*see* page 206).

Malignant Papilloma.—In tracing the life history of a papilloma to the point where malignancy has supervened, we have indicated the ways in which the two differ. The following table will serve to refresh the memory.

TABLE SETTING OUT THE PRINCIPAL DIFFERENCES BETWEEN INNOCENT AND MALIGNANT PAPILLOMATA

	Innocent	*Malignant*
Pedicle	Long, thin → subsessile →	sessile → infiltrating
Villi	Long, fine, sharp, luxuriant	Stunted, swollen, closely packed
Surface	Irregular, like chorionic villi, bright, no necrosis	Smoother, like marine sponge or cauliflower, necrosis, phosphatic deposit
Size	The smaller, more likely to be still innocent	The larger, more likely to have reached malignancy
Number	Often single	Often multiple
Base	No thickening, no œdema	Thickened, bullous œdema
Concomitant lesions	Cystitis absent or slight, and amenable	Cystitis more frequent and marked, generally obstinate
Reaction to diathermy	Good	Poor, may thrive on it

No single character taken by itself is adequate testimony of the nature of the growth (infiltration excepted), and the entire evidence must be reviewed before any conclusion is formed. It is easy to place the obviously innocent and the obviously malignant in their correct categories, but the middle transition stage is more difficult. These growths are frequently bulky, and their pedicles and bases are hidden. The reaction to diathermy should be tried in doubtful cases and will often give a strikingly accurate indication of the growth's proclivities. I have on the one hand seen rapid and permanent disappearance, and on the other hand I have seen the tumour appear to flourish on diathermy. Many authorities put such reliance on the neoplasm's reaction to diathermy in estimating its nature that it has been called the 'therapeutic test'. But this method likewise is not without its drawbacks, for there will be delay before it delivers its verdict. Moreover, we are risking the displeasure of our patient

who, having undergone treatment which held promise and has miscarried, is now advised that more radical measures are necessary. This is a real danger, as further treatment may be refused, to the patient's detriment and with much loss of prestige to his adviser. If therefore a neoplasm remains under suspicion after one or two energetic sessions of diathermy, it is wise to resort to open operation.

The task of placing these borderland growths in their correct categories when first seen is a difficult one. It is not to be expected that surgeons will interpret identically the individual members of these intermediate types. This presumably explains the wide discrepancies to be found in the proportions of innocent and malignant villus-covered tumours which make up the lists of various authors. In the table appended are given the figures of two surgeons. They have been selected to illustrate this contrast —

	Papilloma	*Carcinoma*	*Total*
Egger	38 (47 per cent)	42 (52.5 per cent)	80
Barringer	7 (14.9 per cent)	40 (85 per cent)	47

It is a fair assumption that these surgeons draw their patients from comparable sources, and if so the great dissimilarity in their figures can be explained only by their different individual standards.

Pathological Investigation of a Papilliferous Tumour.—As previously observed, it is possible with the cystoscopic rongeur to remove a portion of the growth for microscopical examination. There is much divergence of opinion in the ample literature about vesical papillomata as to whether more weight should be given to their clinical or to their pathological features. The problem of differentiating a benign from a malignant papilloma or of determining at what point a simple growth has taken on malignancy has baffled pathologists equally with clinicians.

The unreliability of the pathological opinion respecting these tumours is almost a byword, different pathologists having not infrequently given dissimilar reports on the same section. It has happened to many surgeons that a tumour has been reported as malignant and its recurrence as simple, or that a growth regarded by the pathologist as benign has destroyed life by metastasis, or, again, that of one reported as malignant a clinical cure has been effected. Further, a tumour looked on by the pathologist as simple has returned in the suprapubic scar with malignant characteristics and has destroyed life.*

Not uncommonly two papillomata are met with in the same bladder, of which one is apparently simple and the other definitely

* It is well known, however, that the recurrence of a benign papilloma which has been implanted in a wound is invariably cancerous.

malignant. Moreover, malignancy may be discovered in one part of a tumour of which the remainder is apparently innocent. The present writer has seen a case in which a large area of the bladder base was infiltrated by a hard scirrhous mass, whilst close to the outlet sat a small villus-covered tumour of quite different naked-eye appearance. Such mixed tumours are not uncommon, and Fenwick said that 'certain epitheliomata of the bladder are able so to irritate the surrounding healthy vesical surface that benign papillomata spring up.' An alternative explanation would be that a portion of the neoplasm had undergone malignant change which was not shared by the remainder of the growth. These phenomena afford a convenient explanation when pathological reports and clinical course run counter to each other, but show that serial sections of these tumours are required for their satisfactory appraisement.

Further, there is no agreement as to whether the pathological material shall come from the tumour's superficies or from its base, each position having its advocates. Thus Beer, Buerger, Young and Davis, and others have recommended the prominence, whilst Geraghty said that "the base of a papilloma may show no signs of infiltration and yet the tumour may be distinctly malignant in its body and periphery." Later he admits that 'probably in no other tumour have so many mistakes been made by pathologists.' In another paper, however, this writer makes the significant statement that 'in the vast majority of cases there was not sufficient evidence to indicate whether a tumour would respond to fulguration.' Ziegler, Orth, and other writers also favour pathological investigation, but they recommend that the base be examined, and indeed many writers assert that no opinion can be formed from an examination of the superficial portions.

Quite apart from the question of the value of microscopical examination, it must be frankly recognized that there are practical objections which concern the methods of acquiring such pathological material. If it is intended to examine the *superficies* of the growth, this will be obtained by the cystoscopic rongeur. But gentleness is fundamental in handling vesical papillomata because of their great liability to disseminate, and though the danger may in some measure be mitigated by lavage with lotions meant to destroy grafts, it must be insisted that the use of the rongeur violates first principles. Probably microscopy of the superficies of a papilloma is valuable, but the wisdom of practising it is questionable. If, on the other hand, the *base* is selected for examination, it can be obtained only by open operation, and this is unfortunate, for the excision of the growth must then be completed at the time of this operation, and thus doubt regarding the diagnosis may lead to timidity in removal.

These practical difficulties and the acknowledged uncertainty of the pathological opinion have led me to rely largely on clinical, which actually means cystoscopic, data for my diagnosis

Amongst those who hold a view contrary to that expressed above is the staff of the Mayo Clinic, where a preliminary biopsy has been the practice for seventeen years (Bumpus) It is denied that any ill comes from avulsion of the superficial part of the growth with a specimen-taker The neoplastic material thus acquired is then classified according to Broders' system of grading, it being disputed that different portions of a growth exhibit variations in their characters

II. NODULAR CARCINOMA

To the diverse appearances presented by a nodular carcinoma parallels can be found in malignant growths of other regions of the body, so that even the novice will have something to guide him

PLATE VIII

A, Cauliflower carcinoma with some superficial phosphatic deposit B, Irregular nodular carcinoma, the dark objects seen centrally and to the left are changed blood clots C, Nodular carcinoma with flat, ragged, ulcerated surface D, Carcinoma of the uterus invading the bladder Note the elevation of the growth and the central puckering The nodules are multiple E, Enormous transparent bulli occurring near the base of malignant growth F, A nodule of epithelioma implanted at the edge of a patch of vesical leucoplakia Note the rolled everted margin of the growth The silvery blue appearance of the leucoplakia, its sharp irregular edge, and undulating surface are well shown The remaining mucosa is inflamed and several patches of purulent debris may be observed

These appearances vary to some extent in proportion as the neoplasm is elevated above the surrounding mucosa or has undergone ulceration etc. Five characteristic types may be illustrated, and *Figs.* 103 A–F will assist the student in understanding the following description

The tumour shown in *Fig* 103 A projects into the bladder as a fleshy mass of reddish or yellowish-red colour, not dissimilar to that of the bladder, but generally somewhat deeper in shade Often, however, it is of a deep-red hue. The surface is more or less rounded It may be smooth, but is generally irregular and may be much lobulated It bleeds slightly when touched, and ulceration is absent. The growth shown in *Fig* 103 B is not very dissimilar to that of *Fig.* 103 A, but forms a flattened plaque, projecting little or not at all into the bladder and resembling a hard chancre in appearance Its margin is rounded, regular, or sinuous, and its central portion may be flat or slightly retracted Generally it is of a distinctly deeper red than the surrounding bladder wall It bleeds on being touched, and superficial necrosis is slight or absent.

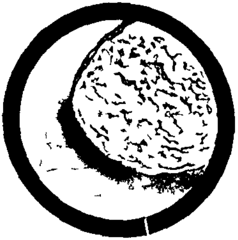
The growth in *Fig* 103 C probably arises from that in *Fig* 103 A as the result of necrosis of the upper part of the prominence It conveys

PLATE VIII

MALIGNANT GROWTHS OF THE BLADDER

A

B



C

D

E

F

the impression that the upper two thirds of the fleshy mass have been roughly sliced off (*Fig* 103 D) leaving a flat but ragged fibrous surface of necrotic tissue (*Plate VIII* C) This surface varies in shape, according to that of the original tumour but is often roughly circular in outline Its edges are sharp but jagged The lateral aspect of the tumour retains the appearances described above for *Fig* 103 A and recedes as it approaches its base of attachment to the bladder

Fig 103 E presents the appearance typical of an ulcerated epithelioma (*Plate VIII* F and *Fig* 104) The surface is irregular ulcerated, red and often covered with flakes of sphacelus The margins are rounded irregular and everted Its appearance can scarcely be mistaken *Fig* 103 F shows the same condition as *Fig* 103 E save that

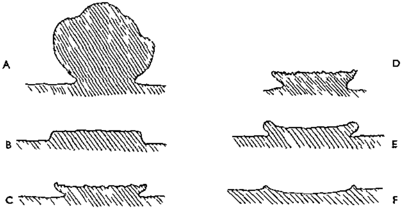


Fig 103 —Types of nodular carcinoma For description see text

ulceration is more rapid and advances *pari passu* with tumour formation There is therefore little or no rampart of neoplasm and excavation is so active that a saucer shaped depression occurs

The growth shown in *Fig* 103 A is probably the least and that in *Fig* 103 F the most rapid whilst the others show an intermediate malignancy The vesical mucosa surrounding the neoplasm may be healthy and normal or may be puckered and infiltrated Frequently there is surrounding œdema apart from infection Cystitis is very common

I have on occasion removed for biopsy part of a nodular growth the appearance of which was not distinctive The objections raised above (page 178) to this form of examination concern papilliferous tumours only and are inapplicable to nodular growths for which it is a satisfactory procedure and devoid of risk It should terminate the cystoscopic examination as thereafter the field will probably be blood stained For the same reason the surgeon should make sure that the pathological material is acquired with the first bite of the rongeur

Number of the Growths.—The number of the papillomata varies widely. They are multiple in one-third of the cases. It is rare for them to exceed three or four save in advanced instances, but up to a hundred or more have been found A painstaking hunt for satellites must always be made The proper time for this is the initial cystoscopy so that loss of time may be avoided during treatment. The search must be deliberate, every crypt and depression being explored for insignificant red spots which may prove to be incipient neoplasms These spots in their early development are closely simulated by certain small rounded thickenings seen in cystitis, and if the latter occurs following diathermy it may be difficult to determine the nature of the lesion Satellites often spring up close to the parent mass and

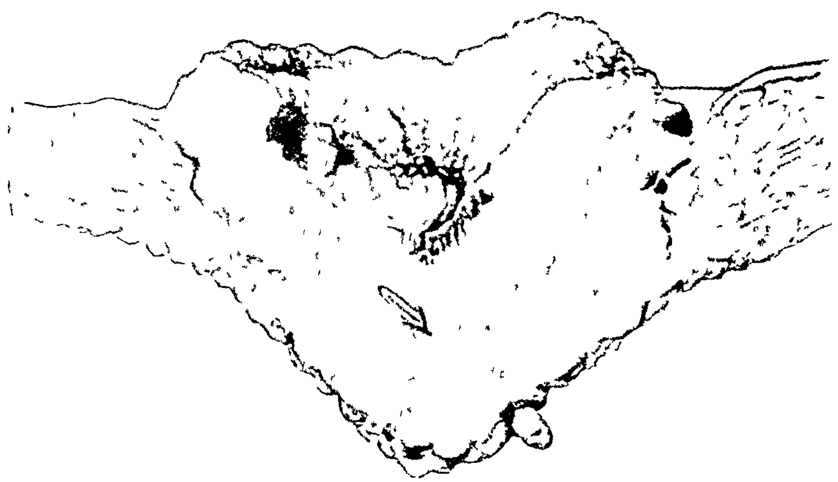


Fig 104 —Infiltrating carcinoma with crateriform ulceration Note rod in ureter Operation specimen (cf *Fig* 103 E)

may then be hidden behind or underneath it, escaping notice until it is destroyed The position of secondary splashes must be charted (*see Fig* 125, page 211) and their size indicated Their destruction will precede that of the main tumour at the first session of diathermy

Multiplicity has not the same significance for all writers Young and Davis hold that multiple tumours are " almost surely malignant ", and Fenwick says that " the prognosis of cure after operation will never be so good or so hopeful in multiple as in single papillomata " On the other hand, Swan and others see in it no additional reason to suspect malignancy Wherever the truth lies plurality unquestionably portends a strong tendency to engrafting and succeeding grafts show a progressive increase in their malignancy

Size of the Growth.—With tumours of small and medium size it is easy to form an approximate estimate of their dimensions With

those that are large it is much more difficult Size has an important bearing on the cystoscopy, as will now be shown

Effect of Size on the Examination—The series of diagrams presented in *Fig* 105 will assist in demonstrating the ways in which the size of the papilloma affects the cystoscopic examination

Fig 105 A shows a small single growth Even with the prism close up it is easily contained in a single cystoscopic field By means of lateral inspection the pedicle may perhaps be brought into view,

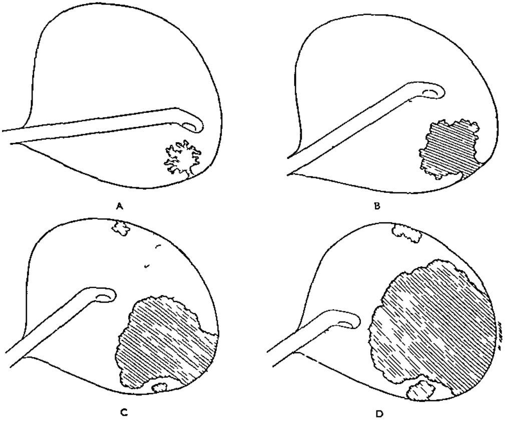


Fig 105—To illustrate the effect of the size of a papilloma on cystoscopy For description see text

though this is by no means always possible No secondary buds are yet seen Such a neoplasm would be quickly destroyed at the first sitting with the high frequency current

Fig 105 B represents the same growth at a later period To encompass it in a single field the instrument must now withdraw to a greater distance Illumination and magnification are sacrificed but it is easy to approximate the prism and examine in detail each component portion of the growth Much greater difficulty will be experienced now in obtaining a view of the pedicle owing to the extensive arborescence which overlaps and shrouds it This overlapping

of the base is important. The appearance of the pedicle should witness for or against malignancy. In actual practice one has, as a rule, to rely on the shape of the tumour itself, on its elevation above the bladder, on the relation of the tumour to its shadow, and on the height attained by its lowest branches, to form an impression of the degree of its pedunculation. Papin has suggested an ingenious method of estimating the breadth of the pedicle. A ureteric catheter is made to underrun the growth in three different directions and palpate the periphery of the pedicle. This, however, is not a procedure which finds favour with the writer, for, unless absolutely necessary, instrumentation of all sorts should be avoided in order to obviate the risk of tumour dissemination. A more satisfactory expedient is, when commencing diathermy, to sink the electrode into the body of the growth so that when the current is running it adheres. Traction on the electrode may then indicate the mobility of the pedicle. In this drawing no secondary buds are figured. A simple papilloma of such size would be destroyed with ease in one or two sessions of diathermy.

In *Fig.* 105 C the growth is much larger. The difficulties of examination have increased materially. It is now impossible to obtain an idea of the tumour's size by examination of any single field. A number of areas must be viewed successively and an attempt made to estimate its size by comparing it with the extent of unaffected and visible bladder wall.

It will be appreciated that an increase in the dimensions of the papilloma inflicts a double disadvantage on the surgeon, in that the tumour is larger and the bladder cavity smaller. Owing to the former there is greater need for cystoscopic manœuvring, and because of the latter there is less space for its accomplishment. In this connection the question arises whether it is wise to augment the vesical fluid. There is some risk in so doing of overstretching the base of the growth and starting hæmorrhage, but the advantages of increased space are so marked that the risk, which is not a very serious one, may be accepted. When found necessary, therefore, gently increase the bladder contents to a maximum of about 16 oz. This, of course, must be done with care if cystitis is present.

In the case of a growth originating on the lateral wall of the viscus, especially if close to the urethral meatus, it is easy to understand that once it has overstepped the median sagittal plane of the bladder a direct view is impossible, and recourse must be had to observation obliquely along its surface.

In *Figs.* 105 C and D, and especially in the latter, this difficulty of orientation is well exemplified, and an attempt to show the positions of the cystoscope in an examination of such cases has been made. Two

secondary nodules have been inserted in the drawings In *Fig* 105 C one of these nodules would be discovered by careful cystoscopy The second and lower one would probably be missed owing to its being overlapped by the main tumour In *Fig* 105 D the growth of the bladder roof also might well be overlooked now that the bladder space is so restricted Note that in *Figs* 105 A and B there is no invasion of the submucous coat This has occurred in *Figs* 105 C and D The question of treatment in growths of this size will be discussed later (page 204)

Large papillomata, especially when growing from the lateral recesses, tend to gravitate towards the bladder outlet Multiple growths in this situation are frequently seen At an open operation

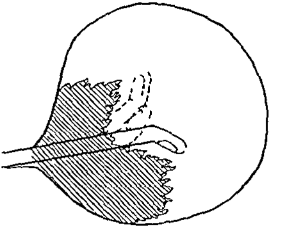


Fig 106 —On entering the bladder the cystoscope plunges through a deep collar of growth To show the difficulty of judging the size of papillomata in this position and especially their depth

they are found packed down into this the lowest portion of the bladder probably carried towards it by the stream of urine The separate tumours fall together their villi coalesce, and their bases are hidden It is impossible to say how many tumours are present until the superstructure is removed It is always surprising that they do not have a more pronounced effect on micturition (*See* however the views of Blanc and Negro on page 198) When a bladder affected in this way is cystoscoped the beak of the instrument passes through a thick collar of papillomatous material (*Fig* 106) before it emerges into the open but it is almost impossible to judge the depth of this collar so as to assess the size of the tumour Any attempt to see the vesical meatus fails because this is completely covered as is also the trigone There is therefore no landmark from which to get one's bearings These growths are amongst the most unsatisfactory from the point of view of perurethral diathermy They usually prove to be quite big and are best treated through a suprapubic cystotomy

Position of the Growth.—

Primary Papillomata.—These have a strong predilection for the regions immediately behind and external to the ureter and inter-ureteric bar. In my experience the trigone escapes though other writers have described growths arising therefrom. As we pass from the base to the fundus and roof their frequency diminishes rapidly. Primary papillomata are quite rare in the upper half of the bladder. Malignancy is greater in the lower segments of the bladder, growths of the roof generally being very benign.

Another well-recognized though less common site for implantation is the internal meatus. In this position the neoplasm covers that orifice as though a coin were placed upon it. It may bleed on the

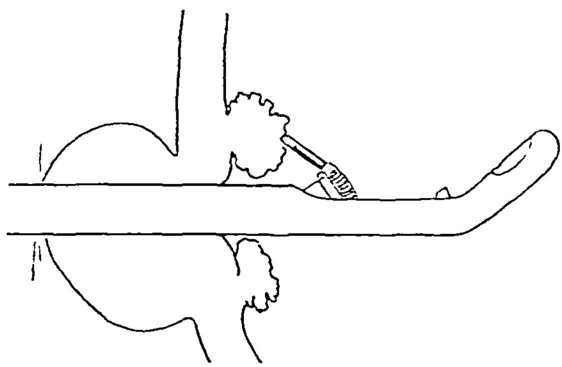


Fig. 107.—Treatment of papilloma covering the meatus by means of the retrograde cystoscope.

introduction of the cystoscope, and its extent is difficult to determine owing to its relationship to the prism. For the examination and treatment of growths in this situation Swift Joly introduced his retrograde cystoscope (*Fig.* 107, and *Fig.* 189, page 316). Apart from it treatment would have to be by open operation.*

Many of the meatal growths are secondaries and are due to villi getting sucked into the meatus during the outflow of urine. The resulting friction detaches cells which engraft themselves around the meatus often in the form of a ring. The urethral mucosa appears to be unsuitable soil for growing papillomata as they will thrive right up to the margin but it is a great rarity to find them arising within

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* The chief value of this instrument is for growths situated half an inch to one inch away from the meatus. I personally find it difficult to approximate the electrode to the actual urethral margin, but this can be satisfactorily dealt with through a posterior urethroscope of the Geringer or Joly pattern after the main tumour has been destroyed through the retrograde cystoscope. The retrograde instrument is not an easy one to use and I have found that, except with quite small growths, it pays better to open the bladder and give the neoplasm a firm session of diathermy.

the urethra itself, even though long villi not infrequently pass some distance down that tube In the female I have seen villi present at the external meatus this being more common with the long slender type of frond

The position occupied by the growth or growths and an approximate indication of size should be entered upon a chart and the drawing kept for reference during treatment Further allusion to this chart will be made on page 210

With tumours of large size it will be impossible to state accurately where the pedicle is implanted until its bulk has been reduced The precise site of origin of an apical growth is also difficult to assign

Secondary Papillomata —Satellite buds do not confine themselves so exclusively to the peri ureteric region as primary ones They are more widely and more evenly distributed over the bladder surface though they are more common near the parent growth than away from it

Nodular Growths —These are as a rule easily located but where cystitis is troublesome an incorrect impression may be obtained both of their position and extent

The Relationship of the Ureters to the Growth —This is important as one of the ureters is frequently involved at its orifice or in its intramural course owing to the site of election of these tumours The implication of a ureter by a neoplasm is occasionally suggested by a complaint of renal pain resulting from back pressure though more commonly the process is silent *Fig* 108 illustrates radiographically the march of a malignant tumour arising near the right ureteric orifice in a patient whose general health was unsuitable for radical surgery The starting dilatation of the right kidney and the overfull ureter are seen in the early films with no demonstrable bladder defect Later the right kidney has become functionless the growth has spread across the bladder to involve the left ureter which is now in a stage similar to that previously seen on the right side and a filling defect has appeared in the first affected part of the bladder The dilatation of these kidneys was quite symptomless apart from the inevitable uræmia which as usual did not show itself till the second kidney was considerably damaged Kidneys so involved are very susceptible to ascending infection *Fig* 109 illustrates the production of a dendritic stone following such infection with a urea splitting organism

The possibility of damaging the ureter by diathermy and causing stenosis must be kept in mind As a matter of experience the ureter is very rarely permanently injured even when energetic burning has been carried out close to it Often it is concealed by a papilloma until a considerable portion of that growth is destroyed when it emerges

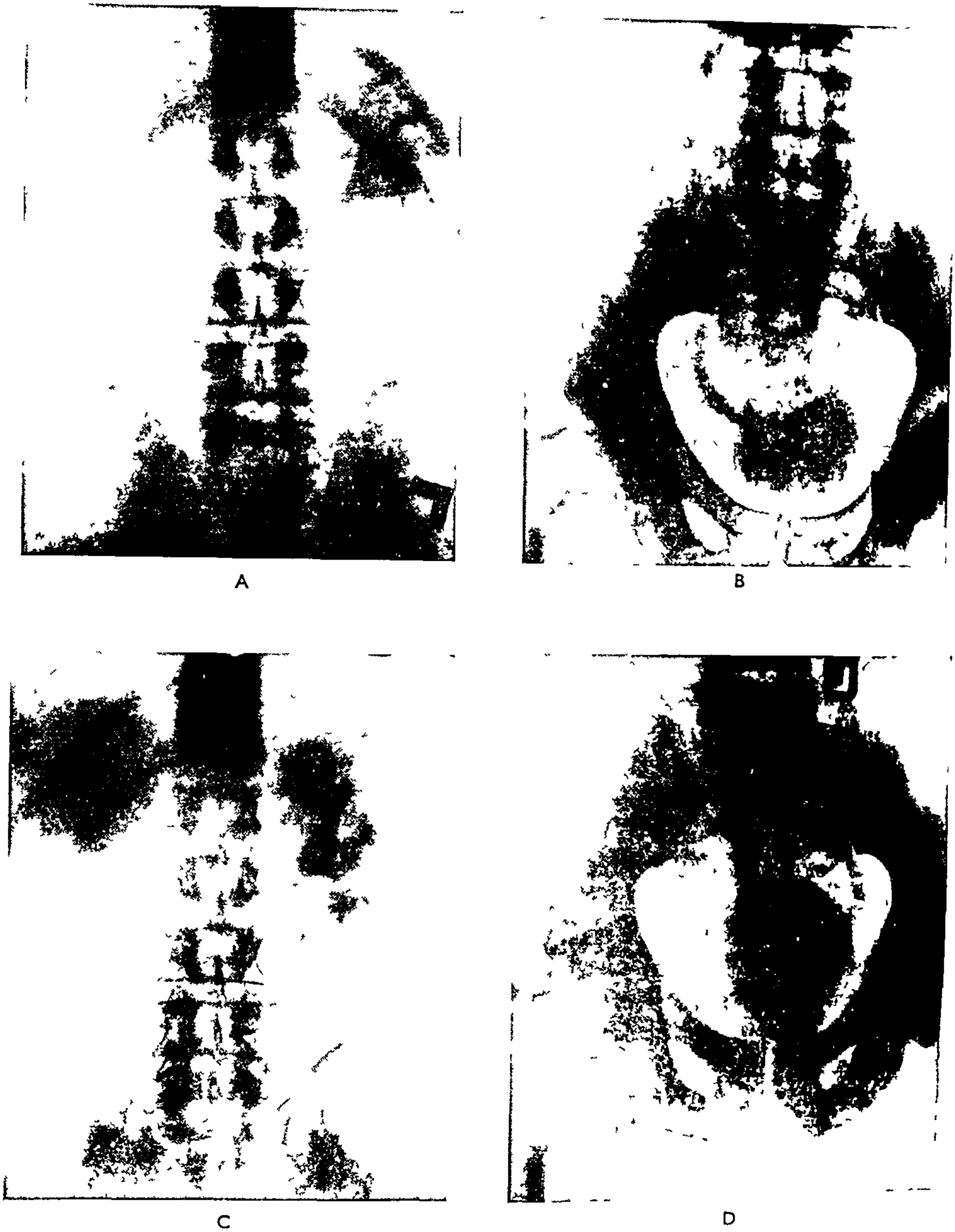


Fig 108 —Four urograms illustrating the progress of an inoperable carcinoma of the bladder base A, Upper tract, right side commencing to dilate Left normal B, Same date as A, bladder shadow rounded suggesting reduced capacity but no filling defect The right ureter dilated and shows no peristaltic nodes—evidently obstructed Left ureter empty C, Four months later Upper tract, right kidney not excreting now, left pelvis showing serious dilatation Contrast with A D, Same date as C, bladder now shows flattening on right side, no fluid in right ureter Left ureter shows the same appearances as B did 4 months previously Note dilatation right down to ostium

again This reappearance becomes evident however not at the time of the treatment, but at the subsequent inspection (*see* page 207)

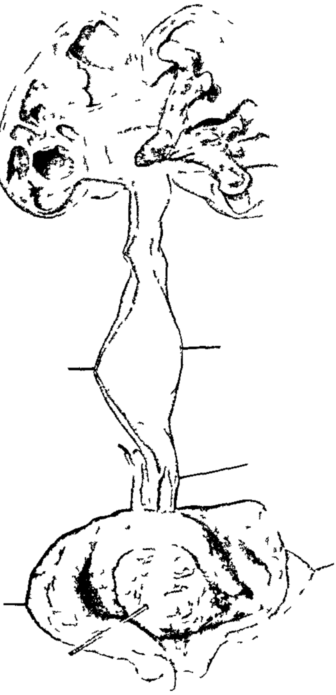


Fig 109 —Papillo carcinoma over the lower end of the right ureter *Dilatation* of the ureter and pelvis Coralliform stone in pelvis Glass rod (passed from above) marks site of ureter

Neoplasms invading the Bladder Secondarily.—Growths not originating in the bladder itself may be: (1) Extensions from elsewhere in the urinary tract, or (2) From parts not belonging to these organs

1. TUMOURS NOT ORIGINATING IN THE BLADDER MUCOSA, BUT EXTENDING TO IT FROM OTHER PARTS OF THE TRACT.—These may

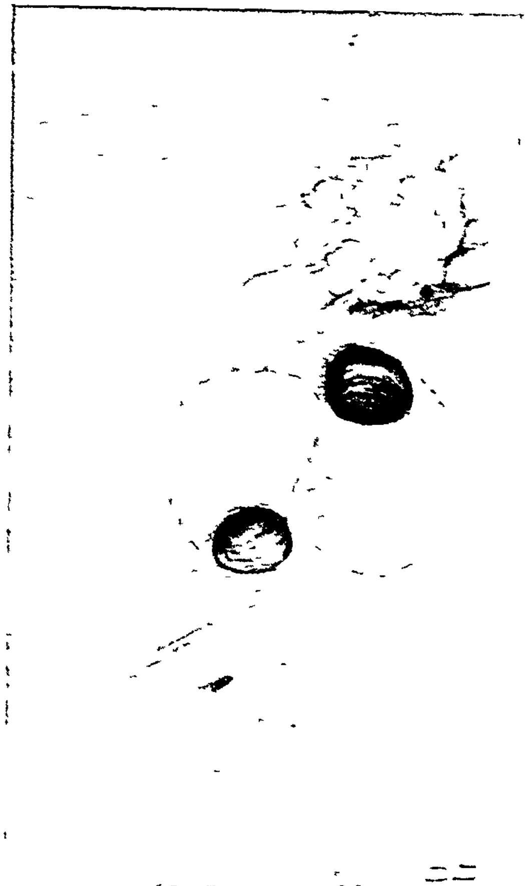


Fig 110.—Two diverticula of the bladder, the upper one containing a papilloma (not visible on surface but indicated by dots) The other growth sessile and puckering the mucosa is seen above the orifice

arise in vesical diverticula, or the remnants of the urachus or they may be papillomatous implantations from the renal pelvis or ureter

Diverticula.—Not infrequently diverticula are the seats of neoplasms (*see* page 163) both villous and nodular. A beautiful example is illustrated in *Plate VII* C, page 172. This growth, when first seen fungated through the opening of the diverticulum into the bladder and hid the orifice. It was only when it had been reduced in size that its site of origin was appreciated (*see Fig.* 99 page 164) Allusion

to the method of treatment adopted for this growth is made on page 209. Another tumour arising in a diverticulum is seen in *Fig* 110. In this case a satellite has formed in the bladder.

Urachal Growths—Tumours presenting primarily at the apex of the bladder and cystoscopically indistinguishable from papillomata or epitheliomata may arise in those remnants of the urachus which persist so commonly within the bladder wall or in its immediate vicinity. Begg indeed states that this is the commonest type of tumour arising in the vault. *Fig* 111 shows such a neoplasm and it can be clearly

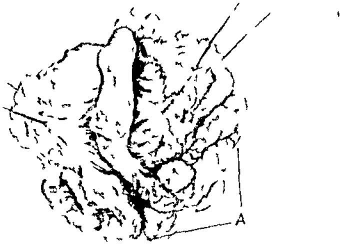


Fig 111.—Operation specimen of a urachal growth laid open to expose the neoplasm as it lies in the canal of the urachus. The intravesical projection corresponding to *Fig* 112 is marked A. The rounded upper pole of the growth was at operation just visible outside the bladder wall.

seen to occupy a channel within the vesical musculature. The intravesical portion is marked A and its cystoscopic appearance is shown in *Fig* 112. Most of these tumours are adenomata or adenocarcinomata and many show colloid degeneration. They originate in the primitive cells of the urachus and their histological type, which closely simulates that of a rectal cancer, betrays an embryological descent from the hindgut of the embryo. A consideration of their site of origin shows the futility of treating them by perurethral surgery. They must be freely excised, a procedure for which their situation renders them eminently suitable. When a primary tumour is centrally placed in the bladder vault the possibility that it is of urachal origin must be kept in mind. The only other adenocarcinomata found in the bladder spring from the so called Brunn's nests (*see* page 83).

whilst confined within the tract the tumour had behaved as a benign one. Any sections of the urinary channels should, therefore, be made with the thermocautery or other destructive agent and the surrounding area should be packed off. For further discussion see article by the author in the *British Journal of Surgery*. 1947. 35. No 138 Oct. 113

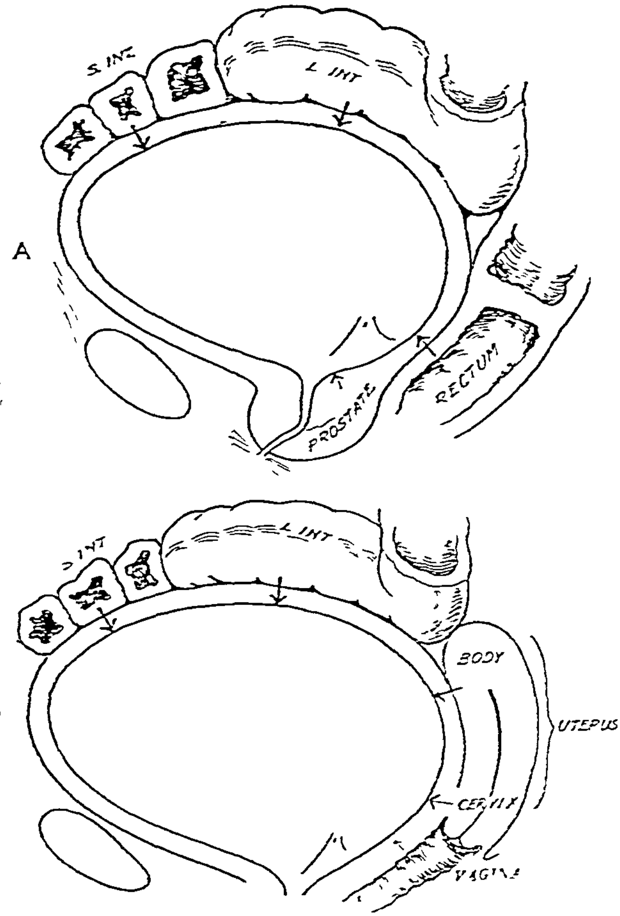


Fig. 113 —Points of invasion of the bladder by carcinoma arising in the various contiguous structures A. Male B Female

2. Tumours arising in Organs not belonging to the Urinary Tract.—Such growths encroach on the viscus at its nearest point (*Fig.* 113): thus tumours of the rectum or uterus* will involve it posteriorly, those of the sigmoid superiorly, whilst those of the prostate will undermine the trigone. When involvement of the bladder secondary to another viscus is diagnosed, the position of the invasion may help to

* The important subject of the effects on the urinary tract of uterine cancer is more fully discussed in Chapter XIX.

decide the primary site of the tumour Tumours originating elsewhere and invading the bladder secondarily are easily distinguished from those primary in that viscus The first alteration generally takes the form of an elevation of the bladder wall Subsequently, however, the growth itself fungates into the viscus or central puckering occurs in the mass as contraction takes place in the underlying neoplasm (*Plate VIII* D page 180) At a later time fistulæ—the vesicó vaginal variety is the commonest—result from perforation A cystoscopic drawing taken from a case of sigmoid carcinoma which perforated into the bladder is shown in *Plate VI* D page 152 The whitish purulent material seen in the centre of the picture flowed into the bladder during cystoscopy and became more abundant on suprapubic pressure

Differential Diagnosis—When the conditions are favourable the diagnosis of a vesical tumour is easy but when cystitis hæmorrhage and a thimble bladder —severally or in conjunction—thwart the operator mistakes readily occur A growth covered with fibrin and muco pus, and especially if encrusted with phosphates is easily mistaken for a calculus Conversely a stone similarly coated in debris may be mistaken for a necrotic tumour The mobility of the stone when touched by a bougie and the fixity and tendency to hæmorrhage of a growth under similar circumstances serve to distinguish them, as will indeed a radiograph Occasionally a circular blood clot occupying the bladder base will simulate an infiltrating carcinoma Subsequent investigation will correct this error

The difficulty in distinguishing between a small papillomatous bud and some of the manifestations of cystitis has already been discussed (page 85) It arises particularly in infected bladders which are or have been the seat of a villous tumour A similar difficulty may be experienced with larger growths—say those the size of a pea Cystitis with proliferation occasionally produces polypoid objects (cystite vegetante) and it may be very hard to decide whether such a lesion is neoplastic or inflammatory The latter are usually more irregular in shape than are new growths are generally devoid of pedunculation and indeed their base is as a rule wider than their apex whilst their swollen appearance and deep red colour correspond to that of the surrounding hyperæmic and œdematous mucosa These vegetations are however extremely polymorphic and may be almost indistinguishable from papillomata This difficulty is particularly experienced at the margin of many large tumours which merge insensibly into an inflamed or œdematous area Sometimes further examination of the bladder will show other similar manifestations close to or in a remote part of the viscus whilst treatment directed against the cystitis may clear that organ sufficiently to allow any true neoplasm to be identified

Endometrioma.—Another tumour invading the bladder secondarily is the endothelioma. The behaviour of this tumour is so different from that of the more usual vesical growths that it is discussed separately (*see* page 213).

Concomitant Bladder Lesions.—Concomitant bladder lesions are frequent. Most of them have already been referred to *Cystitis* is the most important. Its occurrence. especially complicating malignant disease. has been noted. and is so characteristic as to have diagnostic significance. It may precede or follow instrumentation. *Leucoplakia* (*Plate VIII* F. page 180). described on page 250. is an occasional sequel of old-standing cystitis. Malignant degeneration of the thickened epithelium may accompany it. and in this instance the cystitis is. of course. a precursor and a cause of. instead of a sequel to the growth. *Calculus* formation is rare. It is usually of the secondary phosphatic type. Blood stones may occur when hæmorrhage has been severe (*Plate VII* A. page 172). *Fistula* and *diverticulum* have already received adequate notice. In places where the disease is endemic. *bilharziasis* acts as a precursor to various neoplasms (*see* page 147)

CYSTOGRAPHY

Unhappily not a few patients reach the surgeon when the growth is so advanced that even its cystoscopic recognition is difficult or impossible. The bladder may be almost or quite filled with growth cystitis or infiltration may render it small dirty. or intolerant whilst hæmorrhage may be severe and intractable Cystoscopy is hampered and may be of little use. We may then take advantage of cystography By filling the bladder with some radiographically opaque solution (*see* page 157) a silhouette of its cavity may be obtained on an X-ray film A vesical tumour projecting into this cavity will appear as an area of diminished opacity within the X-ray shadow. Though incapable of affording us the detailed information attainable by cystoscopy. this examination will ratify the suspicion that a neoplasm is present: it may show its size and position and may also indicate whether it is villus-covered or smooth. It will further demonstrate the shape and size of the bladder itself. and thereby it is often possible to judge the probability of infiltration.

Benign Tumours.—A benign villous papilloma shows an irregular wavy margin with numerous secondary indentations (*Figs* 114–117) When the axis of the rays is suitably directed the pedicle will be recognizable and breaks the line of the bladder contour. It can generally be located in one or other of plates taken in different axes. When the pedicle lies in the axis of the rays it will not be seen and the gap produced in the shadow by the growth will probably be completely surrounded by contrast solution.

The bladder shadow shows an organ of normal size, and its contour is smooth sharp and regular, except at the points where it is in contact

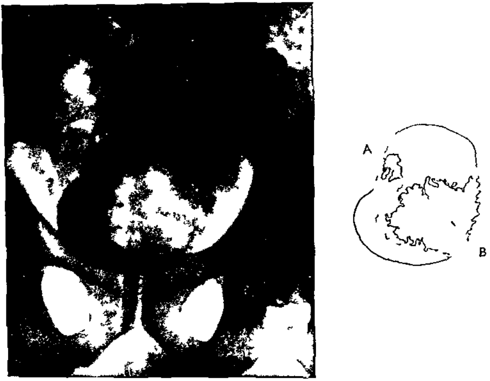


Fig 114—Cystogram of large papilloma and secondary growths A Outlying growths B Main growth

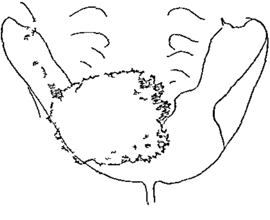


Fig 115—Tracing of cystogram in a case of large left sided vesical papilloma Note regurgitation up the ureter of the unaffected side

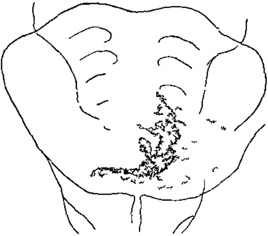


Fig 116—Tracing of cystogram in a case of large papilloma of the right side of the bladder

with the papilloma or its pedicle. Hypertrophy of the musculature is often present in papilloma-containing bladders owing to obstruction and the small irregular indentations to which it gives rise at cystography are quite characteristic and easily recognized once their appearance is known (*see Fig* 85, page 153). Blanc and Negro state that the fronds engage in the vesical neck at a given moment and stop the stream. If radiographs are taken before and after micturition a considerable residual will, in many instances, be observed in the second plate Blanc and Negro appear to have found retention very common in papillomatous bladders. It is favoured by a long pedicle, long villi and also by large growths

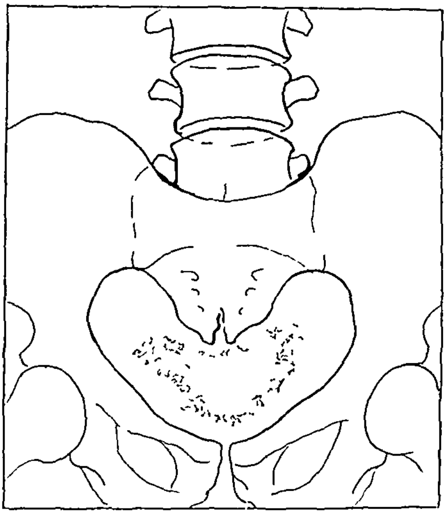


Fig 117 —Tracing of cystogram of a centrally-placed neoplasm

Infiltrating Tumours.—A reference to *Fig* 103 (page 181) will show that an infiltrating tumour may or may not have a noticeable intra-vesical prominence When there is such a prominence its outline is smoother than that of a benign growth, the villi, if present, being stunted or swollen and the tumour relatively solid Owing to the absence of penetration by contrast fluids amongst the villi, the lacuna which the tumour causes within the vesical shadow is more pronounced and has better-defined edges When there is no protrusion but merely infiltration no lacuna will appear on the radiograph But in this case, as also frequently in the case of projecting malignant growths, the bladder itself is modified It is irritable and small Its outline shows considerable change, and much variety of shape may be seen in any series of bladders, largely dependent on infiltration and infection

The following table modified from Blanc and Negro summarizes the principal cystographic features of simple and malignant neoplasms.

		Papilloma	Epithelioma
Vesical capacity	-	Good	Reduced
Bladder outline	-	Regular	Irregular but sharp
'Image lacunaire'	-	Density not uniform	More uniform and intense
		Margins broken, delicate, shade off	Sharper
Bladder evacuation	-	May be incomplete	Generally complete

Similar information may be obtained by intravenous urography, the exposure being made after the bladder has had time to fill with

contrast solution. This procedure has the additional value of indicating renal function and of showing whether there is back pressure on either kidney. (*See Fig.* 108, page 188.)

INDICATIONS FOR TREATMENT

At the cystoscopy the surgeon must make up his mind regarding his line of action. The factors controlling his decision are the size, position and nature of the neoplasm and the age and condition of the patient. Simple villous tumours will nowadays be treated by diathermy unless they are deemed too extensive, when the bladder may be opened for suprapubic diathermy. The effect of size on treatment is reviewed on page 202. Large growths which are felt per rectum or per vaginam are invariably malignant. Many palpable growths are hard and this examination is frequently in itself decisive and may render cystoscopy unnecessary or even undesirable. A growth which can be felt bimanually is always malignant, very large and probably inoperable. When definite malignant change is observed perurethral methods are generally unsuitable. The choice will then lie between open operation and some form of radiotherapy. Open operation may be for: (*a*) The implantation of radon seeds (often preceded by diathermy through the suprapubic wound). (*b*) Partial or total cystectomy. (*c*) Permanent suprapubic drainage.

Considerable judgement and experience are required to assess the needs of any given case, whilst individual surgeons vary in their selection of a method of attack. Hard and fast rules cannot be laid down to govern the choice of cases. Nodular growths when not too extensive and not involving too much of the trigone can be excised. Implication of one ureter does not preclude partial excision, but when both are involved total cystectomy should be considered. The farther away a growth is from the neck and trigone the more suitable is it for removal.

THE PERURETHRAL TREATMENT OF SIMPLE PAPILLOMA OF THE BLADDER

History.—Modern perurethral treatment of bladder papillomata dates back to the year 1910, when Beer introduced the electrode of the monopolar or Oudin current into the bladder through the cystoscope and thus opened the way for the destruction of vesical tumours under observation. His first report included two cases, which, however, were rapidly followed by others from Keyes, Buerger, Wolbarst, etc., so that in 1911, 38 cases could be collected by Beer. The procedure rapidly gained adherents. At first the monopolar current was employed, but it soon gave way to the bipolar d'Arsonval current. With the former the electrode was held at a distance from the tumour

and destruction was obtained by firing sparks of varying lengths thereat In the bipolar method, which I believe holds the field exclusively to-day, the active electrode is introduced amongst the villi of the papilloma and the current passes through the whole tissue of the growth to the inactive electrode, which is situated under the sacrum. This form of treatment had previously been applied to lesions of the surface of the body, growths, nævi, tuberculomata, etc., the only differences between it and the intravesical application being that the latter was carried out under water and through the cystoscope

Technique.—The bladder is prepared in the way described for the examination of the growth For routine work a distension of

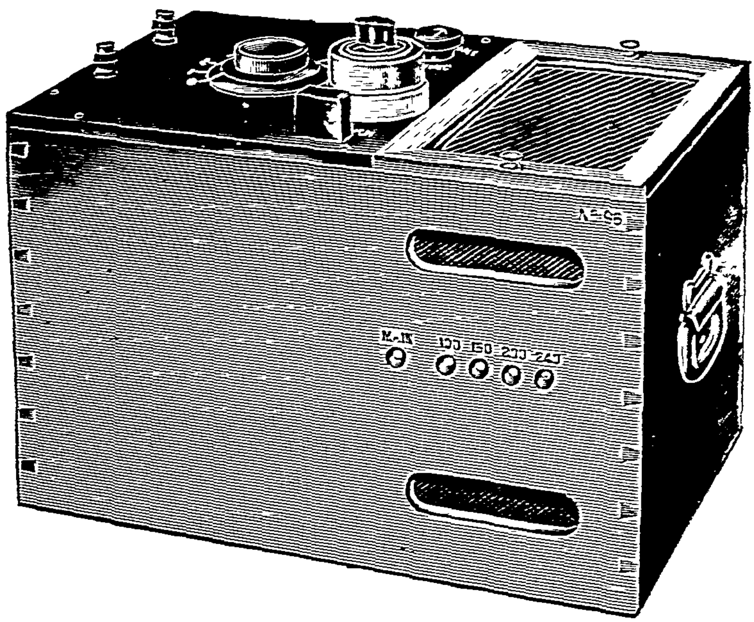


Fig 118—Diathermy machine

8 oz should be employed. Lesser quantities are inconvenient giving too little space, whilst over-distension may be provocative of bleeding The inflamed bladder may, of course, decline to take so much and on the other hand large bladders may be induced to take considerably more, but such an amount should be employed only where difficulty is encountered from the size of the growth The surgeon should then not hesitate to employ up to 16 oz

The patient occupies the usual cystoscopic position, and under his sacrum lies a large flat electrode (7 by 5 in.) which is connected to one pole of the diathermy machine (*Fig.* 118). The other pole is attached to the active or vesical electrode, which is an insulated and supple wire of the size of a ureteric catheter, tipped with platinum

(*Fig* 119) The pad of the inactive electrode is soaked in saline solution The active electrode is sterilized by immersion in antiseptic lotion A single catheterizing cystoscope is employed and after the bladder has been prepared the telescope is introduced and the barrel is loaded with the electrode

In Chapter II the practice of connecting the cystoscope direct to the town's mains as is sometimes done was disapproved When

Fig 119 —Intravesical electrode for perurethral diathermy

that supply of electricity is employed for the diathermy machine a separate source of current to light the cystoscope lamp is essential to safety A Universal machine which is earth free may however, be employed as the low tension circuit containing the cystoscopic lamp has then no direct connection with the main

Satellite buds are attacked first when they are accessible (*Fig* 120) Having been charted at the examination cystoscopy they are quickly located and are generally rapidly destroyed If left until the

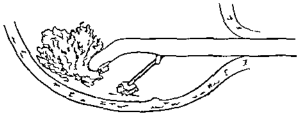


Fig 1 0 —Treatment of vesical papilloma begins with secondary growths if any are present

main tumour has been burnt they may be hidden by debris derived from the latter

After the electrode has been projected the current which is controlled by a foot switch worked by the surgeon himself is turned on A swirl will be seen in the medium and the villi of the papilloma will sway slightly Let the current be weak at the start and increase it gradually The writer estimates the strength required by the effect on the growth rather than by the ammeter As the electrode comes into contact with a villus more marked movement occurs and a

stream of bubbles rises to the bladder summit. If the cystoscope is held vertically over this stream, the bubbles will encounter the fenestra, and lodging there will obstruct vision; but if the instrument is held obliquely, they pass by on their way upwards When bubbles do so obstruct the view they are easily dislodged by rotating the whole instrument so that the fenestra points upwards and then tapping the barrel, when the bubbles will rise to the bladder apex Sometimes they may be more simply removed by withdrawing the telescope momentarily into the catheter Blanching and coagulation occur in the area of the papilloma which is in contact with the electrode The longer the two remain in contact, the wider and deeper becomes the extent of the charring, and the central portion eventually turns black This eschar is non-conducting to the electrical current, and the consequence is that sparking takes place to adjacent portions of the growth Not infrequently a miniature explosion occurs as bubbles imprisoned in the growth force their way to the surface.

PLATE X

A, A small papilloma prior to treatment Note its delicate villi each containing a vessel The intravesical electrode (foreshortened) is seen in the foreground ready for application B, Electrode in contact Note the white eschar with a dark centre and the gaseous bubbles rising to the vesical vault C, Treatment completed D, Seen twelve days later A central unhealed ulcer with surrounding hyperæmia and slight œdema E, The area of implantation at end of two months, now avascular

When the current is working at good pressure a hissing noise is produced in the bladder, and is conducted to the surface by the shaft of the instrument

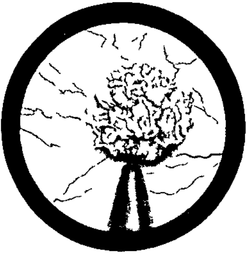
The current is switched off before any attempt is made to withdraw the terminal, and then it will be observed that the tip has adhered to the neoplasm and must be forcibly detached. Often it retains its hold stubbornly and ultimately carries away with it a portion of charred tissue This does not occur until the process of cauterization has been pressed home deeply at a given spot Charred debris acts as an insulator and must be removed Sometimes this can be done by withdrawing the electrode into the barrel of the cystoscope the diathermic current being, of course, turned off Contact with the walls of the catheter may detach it Usually however, it becomes necessary to withdraw the electrode completely for more effective mechanical cleansing as by scraping

Size of the Growth.—The size of the neoplasm has an important bearing on the treatment

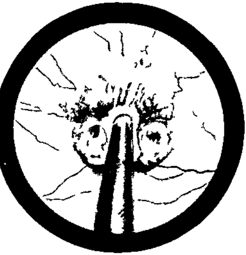
Small Papillomata—Growths the size of a large pea or a small marble may be quickly destroyed by the application of the electrode at three or four points (*Plate X* C) Complete blanching of the

PLATE X

PERURETHRAL TREATMENT OF VESICAL PAPILLOMA



A



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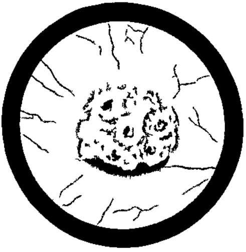

C

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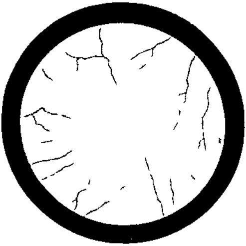


E

growth is obtained, and at the finish the electrode is sunk into the mass centrally and held there in order to obtain destruction of the pedicle Examination after a period of three weeks will demonstrate the disappearance of the growth If the whole of the actual papilloma is not only destroyed but also removed the base from which it grew will be laid bare The bladder mucosa may be burned quite deeply at this point taking in as a precaution against recurrence a small surrounding ring of apparently healthy membrane No anxiety regarding the possibility of a perforation need deter the operator as the writer has never seen this happen

Larger Tumours—These will probably require many points of contact and more than one sitting With a growth about the size of a small walnut high frequency may be applied to the whole of the surface at a first sitting and material decrease in its size be obtained It is well as a rule to start with the part farthest from the operator, placing the electrode behind the growth and burning its distal or upper surface If the reverse process is adopted this area will later be hidden from view by charred debris lying in front of it The nearer portions are then systematically attacked When a new spot is being selected for application of the current it should not lie too close to the previous zone for the surrounding area is already doomed whether it appears so or not (*see* page 207) A second application in three weeks time will probably complete the work on a tumour of this size and render the bladder free from growth though the speed of reaction to diathermy varies with the degree of malignancy

Should one ignore the surface of the tumour and direct one s energies to the pedicle thus as it were undermining it ? This suggestion is frequently put forward and is unusually attractive In practice however it proves disappointing Most tumours have a rounded squat formation and though they may have fairly long pedicles yet the branches swoop down and conceal the main trunk with a spacious arborescence which precludes direct application of the electrode Occasionally however one does come across a particularly long pedicle which invites division

The same principle may be applied to secondary branches of the the growth by turning the cystoscope on to its side and cutting into the mass laterally A whole frond may thus be cut off low down and fall away—a manœuvre which is economical of time It is doubtful, however whether the procedure is wholly wise Cells from the surface of the papilloma are capable of being detached and re implanting themselves with the production of grafts Is not such implantation specially likely to occur if masses of unnourished growth are recklessly thrown down on the healthy bladder wall ? It is probably safer to adopt the more tedious and

laborious process of killing the tumour from surface to base with the assurance that each portion of detached growth is previously devitalized

Large Growths—With each increase in the size of the tumour the surgeon's difficulties multiply, until at length it becomes questionable whether the case is suitable for perurethral treatment at all. To deal with large papillomata Kidd introduced a special diathermy cystoscope (*Fig* 121), in which a large electrode forms the beak of the instrument This electrode is capable of carrying much heavier currents than the usual pattern, but it demands the greatest care and much experience to use it safely Heritage and Young have also designed instruments to deal with large growths

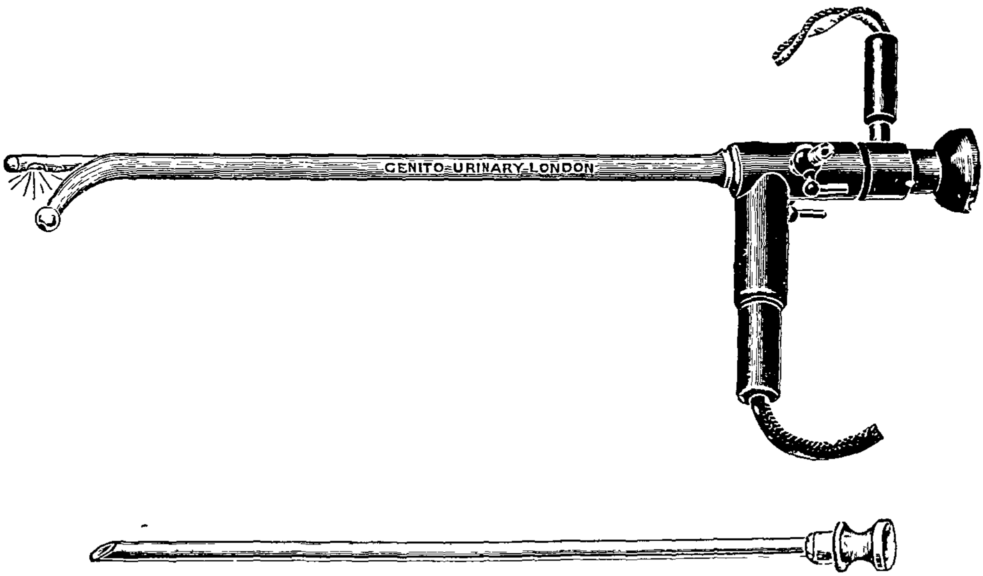


Fig 121 —Kidd's cystoscope for fulguration of large papillomata

When a large neoplasm is benign, one must decide whether to set out on a protracted course of diathermy or to open the bladder and, by employing a combination of cutting current and diathermy, to destroy the tumour (*see Lancet*, 1931, Dec , page 1403) There are disadvantages with each method, for prolonged and repeated endovesical treatment is trying alike to patient and surgeon, whilst with the open operation comes the danger of wound implantation, the longer convalescence, and the fact that the patient does not entirely escape subsequent cystoscopies and perhaps diathermies. Most surgeons, however, at a given stage decide on open operation, though the point at which the transition is made will differ with different workers and with the features of the individual growth Amongst other things the position occupied by the neoplasm has its

influence Thus a tumour the size of a golf ball lying well back in the bladder opposite the surgeon might be dealt with per urethram whereas if a growth of similar size lay over the vesical outlet (see page 186 and Fig 106) open operation should be preferred In borderland cases a first or probationary sitting may be tried as thereby the size of the tumour may be reduced so that treatment will be easier at a subsequent date Where it is difficult to manœuvre the cystoscope so as to get a reasonably good view of the growth points are selected remote from the bladder wall in order to ensure the latter against damage Thus certain tumours which at first sight appear unsuitable for perurethral treatment may ultimately be destroyed

Clarity of Medium —As the work proceeds the bladder medium becomes cloudy This results from the charred debris of the treated surface floating out into the vesical fluid and rendering it opaque Turbidity is much more troublesome with large and luxuriant growths than with smaller ones whilst with the smallest it scarcely interferes at all In the last mentioned such debris as there is remains adherent to the papilloma or falls quietly on to the bladder base In middle sized tumours re washing becomes imperative after five or ten minutes treatment Gradually the medium becomes so cloudy that only a vague impression of the bladder contents is possible At this stage the cystoscopist who has watched the papilloma and its surroundings during the transition from clear to opaque can still effectively and safely apply his treatment even though it would now be difficult to demonstrate the growth to another observer and it is advisable to continue well into this phase lest irrigation be too frequently resorted to and time be lost Safety is guaranteed by keeping to portions of the villous tumour which are known to be remote from the bladder wall, and by restricting the movements of the electrode

Re washing —Advantage should be taken of the properties of the irrigating cystoscope when re washing the bladder for not only does this obviate the passing of a fresh instrument but its thin walls and consequently large bore allow rapid entry and exit of fluids with greater disturbance of vesical debris and therefore more rapid cleansing of the field With this instrument half a minute suffices for the whole procedure The eye of the instrument during the inflow should face the growth By this means the debris on the papilloma and the bladder base is disturbed and a more effective clearance is obtained Before emptying out the lotion the fenestra must be rotated so that it points away from the growth lest the latter should be sucked into it On re examination of the bladder the improvement in visibility is gratifying but inspection of the tumour generally suggests an unsatisfactory extent of destruction The burning however, goes deeper

and farther afield than present appearances indicate, as will become evident at a subsequent date (*see* page 207)

Duration of Treatment.—Treatment is carried on in the case of small or medium-sized tumours until total destruction appears to be achieved. In larger growths either of two factors may be responsible for terminating the session When the tumour has been fulgurated over a large area it becomes covered with semi-adherent powdery debris which detaches itself at every touch of the electrode and so renders the medium turbid Further, this adherent debris is a non-conductor of electric currents, and it is of little value to apply diathermy through it For these reasons treatment cannot usefully be carried on beyond a certain point, which is reached as a rule in about half to three-quarters of an hour

Anæsthesia.—A papilloma is insensitive and can be burnt freely without evoking pain, if the bladder surrounding its base, which is sensitive to thermal stimuli, is safeguarded The question of anæsthesia really turns on the amount of time that will be occupied by the treatment, and therefore on the tumour's size Large growths are taken into the hospital wards and given treatment say up to three-quarters of an hour in duration To these patients a general or a spinal anæsthetic is administered, chiefly because of the discomfort of so long a cystoscopy The use of ether in the presence of a diathermy machine requires the usual precautions Small growths are treated in the Out-patients' Department, where also the late sessions of diathermy for large ones are given For these a local or sacral injection is sufficient but a low spinal is not contra-indicated in out-patients

Period in Hospital.—Cases treated in the Out-patients' Department return home immediately The stay of a patient admitted to hospital is regulated by his recovery from the anæsthetic rather than by the condition of his bladder As a rule he leaves his bed the day following operation and is discharged on the subsequent day

Date of Return for Examination.—The patient is instructed to return on a specific date for re-inspection Whether he returns to the ward or to the Out-patients' Department depends on the surgeon's impression of the amount of destruction attained, and his idea of what the growth's size will be at the next session.

It is a mistake to inspect the organ before an interval of three weeks has elapsed, as sloughs and debris require this period to separate completely Moreover, a certain amount of bullous œdema and chronic infiltration may still remain round the cauterized spot, giving an appearance suggesting malignancy Cabot calls this a 'pseudo-carcinoma', and states that it may last as long as three months We know that it was not there when treatment began and may therefore

assume that it is due to the burn, but if any doubt exists as to its nature fulguration in its immediate vicinity should be avoided until any inflammatory induration has had time to subside, otherwise the cystoscopist may again and again be misled by the appearance of infiltration which looks to be neoplastic but really results from his own treatment I have not infrequently had patients referred to me on account of such a 'pseudo carcinoma' In each case the surgeon had reburnt the supposed growth to obtain a cure In each as should have been foreseen, the lesion was aggravated, but under expectant treatment it subsided completely If after a reasonable period of waiting the cystoscopic appearance remains indeterminate a bite of the affected wall may be removed by the rongeur for microscopy but there is some danger of obtaining only the inflammatory area around an actual tumour as in five instances recorded by Frater in which such material was reported upon as inflammatory, in each the disease eventually showing itself to be malignant

The opposite mistake has also been made a pseudo carcinoma' being removed operatively whereupon its inflammatory nature was discovered by microscopy (Barney) Prolonged cystoscopic vigilance is apparently easier and more satisfactory than any other mode of investigation as, should the lesion be due to the burn, it will recede, whereas if it represents malignant infiltration it will progress

Another lesion which may be wrongly construed is a patch of unhealed mucosa whose velvety granulations floating under water and seen with the high magnification of close cystoscopic inspection may simulate a bud of neoplasm Three or four weeks therefore should be allowed to elapse in order to permit the separation of sloughs and the disappearance of such pitfalls to correct diagnosis

When the diagnosis of vesical papilloma is first made the patient should be advised of the necessity for repeated treatments and inspections He should be told that the cessation of hæmorrhage must not lull him into thinking that the growth is cured If the probability of relapse and ultimate unsatisfactory progress of the disease is carefully explained there will be but few delinquents

Effects of Treatment—At the examination three or four weeks after the diathermy it is always interesting to discover how much of the papilloma has disappeared Usually the destruction is greater than was foreseen It is not uncommon indeed when a papilloma has been treated without any expectation of its disappearance to re examine at the end of a month and find it gone Whilst this may be gratifying in one way, it is a matter for apprehension in that the base has not been adequately cauterized Generally however a search will demonstrate an area of hyperæmia in the position previously occupied by the papilloma and the application of an

electrode at this point will allay anxiety For this reason it is not good to allow the period between cystoscopies to overrun four weeks lest this indication should vanish

The large extent of devitalization is explained by the way heat is developed in the tissues through which the current passes on its way to the inactive electrode The whitened tissue seen through the

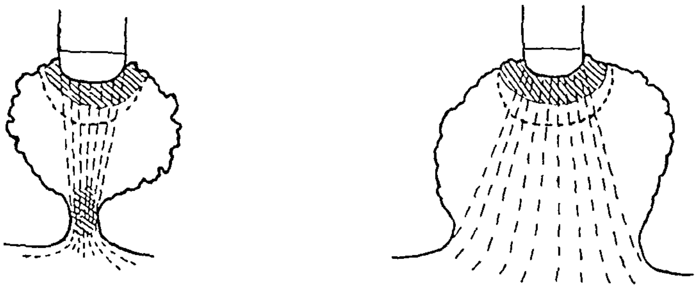


Fig 122 —Diagrammatic representation of the course of the diathermic current in papilloma with A, A small pedicle, and B, A broad pedicle

cystoscope represents only the zone of intense heat around the point of the terminal where actual coagulation is taking place Heat, however, is developed in greater or less degree at every point between the two electrodes, its intensity diminishing as the cone of tissue through which it is passing broadens out (*Fig* 122 B), so that the visible area of white charring overlies one in which the current density is insufficient to cause coagulation, but is nevertheless sufficient to

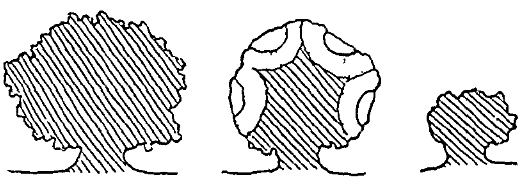


Fig 123 —Illustrating effects of diathermy on a papilloma A, Original growth, B, The apparent destruction at end of session, and C, The appearance presented at a subsequent sitting

devitalize the cells This tissue, which appeared unchanged at the time of the treatment has died and disappeared at the end of three weeks (*Fig* 123)

Concentration of Heat on the Pedicle —The amount of heat therefore, developed in any tissue is proportional to the current density If a papilloma has a thin pedicle, the current is highly concentrated on this structure (*Fig* 122 A) and its devitalization is always a possibility Presumably the unexpected total disappearance of tumours is

thus explained. *Fig.* 121 depicts a piece of papilloma passed per urethram by a patient about a fortnight after treatment, the pedicle having been destroyed by such concentration of the current. Another interesting example was seen in a man who developed a papilloma in a diverticulum (*Plate* VIII C, page 172), and the growth attached to a spot far out of sight could not be directly cauterized under inspection. The diverticulum and growth should have been treated by open operation, but on other grounds the case was unsuitable for so serious a procedure. Diathermy was therefore applied to the protruding surface of the growth and was continued persistently. No recurrence of the neoplasm showed itself during a period of two years in which the case was under observation, which is fair evidence that the destruction was complete in spite of the impossibility of reaching the base of the growth.

Fig. 121.—Piece of papilloma passed per urethram fifteen days after diathermy. (*Natural size.*)

Fig. 122 A and B also demonstrate the safety of the bladder wall from burning, as the current on reaching it is immediately dissipated in all directions, and the amount of heat generated is very small. Burning of the viscus can therefore only take place when an electrode is in actual contact.

The site previously occupied by a papilloma seen at the end of a three weeks' interval may be difficult to identify, so closely does it approximate to the normal bladder mucosa. However, at this period an area of hyperæmia may generally be detected, and occasionally well-marked bullous œdema, which disappears within a week or two, or even a thermal ulcer may be seen. At the end of eight weeks the site is marked by a few leashes of blood-vessels converging on an avascular spot (*Plate* X E, page 202). When the growth has been incompletely destroyed, its appearance will vary with the degree of destruction obtained. The areas over which the cautery has been effective lie lower than previously and may be fringed by longer and sometimes straggling portions which have escaped burning. The former are generally smoother and more granular in appearance and perhaps a deeper red than is the ordinary papilloma tissue.

Recurrence.—Recurrences after apparent cure may show themselves early or late, at the site of the original growth or away from it, or as a general papillomatosis. *At the site* of the original tumour recurrences are due to inadequate destruction of the papilloma base. It is interesting to note that after the first three months they are very rare. Cardner sent round a questionnaire on this point, and found that only a single case—and that one of his own—could be traced. It showed itself at the end of three years. Another writer

whose patients had been unfortunate in the number of recurrences from which they had suffered, states that these had almost invariably taken place at a site remote from the primary growth

Recurrence *elsewhere* may be due to secondaries present at the time of the operation, but so small as to be invisible, which have now grown into evidence Suspicion may be aroused that they result from the implantation of cells knocked off during cystoscopy As a prophylactic measure against this complication, the irrigation of the bladder with weak silver nitrate solution (1–1000) after treatment is valuable, as thereby possible implants are destroyed. In addition, a couple of ounces may be left in the bladder for the patient to pass later.

Whenever a bladder is found to contain more than three or four tumours, we may prophesy a continual tendency to relapse Recurrences caught early are rapidly and easily controlled by diathermy, they should not be allowed to get out of hand if the follow-up system is efficient

Follow-up Record.—The following-up of these cases is one of the most important parts of their handling My own system is as follows —

After the papilloma is considered to have been destroyed the bladder is inspected once at the end of a month Thereafter two examinations are made at three-monthly intervals, and three more at six-monthly intervals That carries us over a period of two years In isolated cases where the growth was very large or presented doubtfully malignant characteristics further inspections may be recommended. At each of these cystoscopies the whole of the vesical mucosa is carefully scrutinized, whilst the site occupied by the original tumour and by any secondary splashes receives special attention Any recurrence is caught when very small and easily destroyed I keep a record book (*Fig* 125) of bladder tumours in which the original condition, position, and number of growths are charted, and the history is entered, together with my original impression of the prognosis On the back of each sheet are noted the way in which the tumour is reacting to treatment, the time when it is proposed to treat it again, and whether the patient must come into the ward or to the Out-patients' Department, etc In this way patients are not overlooked as is liable to happen when numbers of similar cases are under treatment at one time

Post-operative Complications.—A little discomfort on micturition, especially on the first occasion, is usually all that is observed, though occasionally a patient complains of abdominal pain, groin pain, or pain in the back, which is attributable to the cauterization of the bladder wall itself Two complications, however, claim our attention.

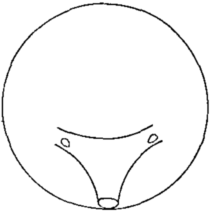
Vesical Papilloma Follow up Record

Name *Address*	*Sex* *Age*	

Size

Number

Prognosis



History

Remarks

(Heading of the back of Record)

Instructed to return	Returned	Treatment and Remarks

Fig 125—Record book for bladder tumours

Hæmorrhage—This is a complication which according to Beer occurred in 3 out of 200 cases (1½ per cent) It is therefore rare It may happen shortly after the treatment or at the period when the sloughs separate It is generally not severe and can usually be controlled by rest

Sepsis—After diathermy a necrotic mass is left behind which offers itself as pabulum to any micro organisms present so that sepsis must be meticulously guarded against The responsibility of keeping a bladder clean through a long series of cystoscopies requires emphasis

These patients must be flooded with hexamine for twenty-four hours before, and a week after, operation Further I irrigate the bladder, as before stated, with silver nitrate after the fulguration, and leave a couple of ounces in the viscus for several hours

The presence of *severe* cystitis prior to diathermy should be regarded as a contra-indication to that operation, and a determined effort should be made to get it under control before such treatment is adopted If this proves to be impossible open operation should be considered The choice will, however, depend on the degree of the sepsis Even if it were advisable to treat a papilloma in a considerably inflamed bladder the treatment would be difficult because the surrounding redness and œdema hide small buds and indeed may simulate them and also because the inflamed viscus resents manipulation Malignant cases are more susceptible to sepsis than are simple ones, and the cystitis is much more difficult to cure

Cystoscopic Implantation of Radon Seeds.—The cystoscopic implantation of radon seeds into or around a tumour is at first sight an attractive proposition and instruments have been designed for the purpose and have achieved some popularity, especially in America The actual delivery of seeds at a correct depth and position is in the writer's view more satisfactorily carried out through a cystotomy wound and even here may prove to be a finnicky task Correct disposition, especially on the distal side of a growth, is almost impossible cystoscopically

Ralston Paterson considers that seed implantation through the cystoscope should never be considered for malignant disease as the radiation distributions so obtained are inevitably very poor He advocates gold seed implantation at cystotomy to give a dose of between 6000 r and 7500 r The use of seeds in this way allows the bladder to be closed which is not possible if radium needles are used

Stanford Cade says " The advantages of the endoscopic methods are outweighed by the following disadvantages (1) The wall thickness of the seed is limited by the bore of the instrument, this means that the screenage is limited to 0 3 mm of platinum, severe reactions follow and risk of infection is increased (2) The distribution of small radium foci in regular geometrical patterns is difficult with the result that except in very small lesions, some areas are over-irradiated, whilst others receive a sublethal dose The technique of choice is accurate needling under direct vision through a wide suprapubic cystotomy "

CHEMICAL COAGULATION OF BLADDER TUMOURS

Joseph introduced the method of coagulation of bladder tumours with trichloracetic acid. Crystals of this substance dissolve in their

own water of crystallization when heated and form a concentrated strongly corrosive solution, which however has the disadvantage that on cooling it rapidly re-crystallizes To prevent this 5 drops of glycerin are added to 4 or 5 c c of the concentrated solution and this together with the syringe which is to be employed is kept warm on a water bath The tumour itself is very sensitive to the action of the acid The cystoscopist identifies it and lays the end of a ureteric catheter against it A small quantity (not more than 3 c c) of the acid is then very slowly syringed by an assistant through the catheter on to the surface of the growth, which blanches and in due course dies and disappears The acid is heavier than the bladder solution and should therefore be poured from above on to the tumour The pedicle of the growth is best treated by thermo coagulation The bladder wall appears to be relatively insensitive to the action of trichloracetic acid and rapidly recovers if some is accidentally spilt on to it This method can be used for large tumours which are difficult to treat by electro coagulation

ENDOMETRIOMA

Endometriosis of the bladder was first described by Starr Judd in 1921 Since that time between 65 and 70 cases have been recorded The disease is therefore not common The essence of the condition is the presence in the bladder wall of tissue apparently identical in structure and function with that of the normally situated uterine mucosa The resemblance in function is shown by the fact that it menstruates at the periods, and that if pregnancy occurs it undergoes decidual change similar to that of the gravid uterus These features are quite evidently governed by the stimulus of the ovary as if the latter is removed by the advent of the menopause (natural or artificial) the symptoms almost invariably disappear and the lesion retrogresses

Prior to 1921 examples have probably been reported as adenomata (Morson) angiomata (Mueller) or carcinomata The tumour occupies that portion of the posterior bladder wall which is invested with peritoneum Its structure is similar to that of endometrial tumours found in the pelvis in the inguinal canal in operation scars and at the umbilicus and consists of acini arranged in a vascular stroma and lined with columnar epithelium similar to that of the uterus In some cases the growth appears to have grown from the peritoneal aspect and invaded the viscus (Plaut Whitehouse) In others it is entirely intravesical (Morson Weitjlandt) The most striking symptom is hæmaturia but vesical discomfort tenderness pain and frequency are invariably complained of All symptoms are aggravated by menstruation though pain and hæmaturia occuring at this time may long be disregarded because thought to be uterine in origin The

menstrual products are for the most part imprisoned in the tissues of the bladder wall as no true outlet is available as in the uterus The resulting tension is responsible for both the pain and also for the grape-like œdematous blood-cysts which characterize the disease

Cystoscopy shows an irregular submucous swelling situated in the retrotrigonal area which is usually engorged with blood The blue-black blood-cysts above mentioned resemble grapes and no comparable picture is seen in any other vesical condition During the menstrual flow the tumour is much increased in size and congested At this time profuse bleeding, perhaps with clotting, may make conditions unsuitable for cystoscopy In some reported cases the ureter is caught in the swelling A vaginal examination usually discovers a tender mass in the anterior fornix The cyclical nature of the symptoms the characteristic cystoscopic picture, and the presence of a lump felt per vaginam establish the diagnosis if the condition is known

Treatment varies with the patient's age For those approaching the menopause ovarian irradiation gives satisfactory results For younger patients desirous of having a family resection of the tumour must be considered

BLADDER CONDITIONS SUBSEQUENT TO IRRADIATION

Some post-radiation reaction on the part of the bladder is invariable after the use of radium, radon, or deep X-ray therapy, but the degree of reaction is very variable, depending for the most part on dosage and proximity A vesical lesion may be the objective of the treatment or the bladder may be involved during the treatment of some other organ The most severe burns are seen after the irradiation of carcinomata of the uterine cervix

Three types of reaction will be described —

1 The point at which radon seeds have been inserted shows some reaction which is usually inconsiderable It doubtless arises from a variety of causes in part from trauma partly from the irritation of a foreign body, possibly from infection, and finally from reaction to the radon It amounts to little more than slight œdema and a blush over the small area around the seed Later it is not unusual for the seed to be visible during a routine follow-up easily recognizable below the surface of an otherwise completely normal mucosa and I have seen it in process of extrusion from the membrane prior to being passed with the urine

2 The mucosa of the bladder reacts to irradiation directed to itself (especially for vesical neoplasms) or to some neighbouring organ —rectum uterus, etc It responds much in the same way as other mucous membranes do, with redness and swelling which reach an

intensity proportional to the dose received. The focal point of the treatment may exhibit a fiery redness shading away quickly to normality, or the whole organ may be suffused in varying degree. If a given area has received a sufficiently large number of roentgen units it becomes covered with a greyish white mantle consisting of mucoid material, epithelial debris and phosphatic deposits. This mantle is usually easily removed by a cystoscopic catheter or electrode, exposing a shallow, ulcerated patch of variable, but usually small extent. The peak reaction occurs in ten to twenty days and settles tardily.

At a *later* time when the œdema has subsided telangiectatic changes constitute the most characteristic picture and they are frequently seen. They are comparable to the skin changes seen at the site of an X ray port of exposure, where areas of deep red or purple staining—coarse, punctate spots separated by portions of pale skin—are familiar sights. The bladder lesion shows the same punctate appearance but the spots are in my experience finer, being invariably like multiple closely placed, sharply defined pin point dots covering an area the size of a sixpenny piece or a shilling, somewhat larger, more strongly marked and more deeply coloured at the centre of the affected area and shading off towards the margins. The intervening mucosa is healthy to all appearances, showing no œdema nor scarring, but may be paler than usual, and the punctate dots, varying in colour from bright red to purple, stand out clearly. This picture is quite characteristic. It persists indefinitely in the bladder as it does on the skin.

3. The proximity of the uterine cervix to the bladder and the fact that no satisfactory way has yet been devised to protect the latter organ during irradiation of the cervix (for cancer and various other uterine diseases) accounts for reactions in the bladder, certain of which are rarely if ever seen except when they follow treatment of the uterus. The dosage applied for these different diseases varies widely and is regulated by the needs of the particular disease, but in every instance the bladder gets some irradiation from the cervical field. The reaction depends on the number of units received, but it is of two distinct and definite types occurring at widely separated intervals of time. The first type develops during the peak of the reaction in the uterus and other tissues. It is the customary response of any membrane to irradiation as described above, but may be severe because of the proximity of the treated area and the high dosage.

The second type is a delayed manifestation which comes on after a period of months or years, during which the patient has probably enjoyed good health, or at any rate the bladder has been giving no trouble. Symptoms of intense vesical distress with frequency and strangury make their appearance quite suddenly. The main cause of the trouble is an obliterative endarteritis which by interfering with the

calculi may prove too hard for crushing. A moderate degree of cystitis should not deter the operator. The bladder wall is but little damaged by skilful lithotrity and will quickly recover when freed from its incubus. Further, phosphatic stones arise in septic bladders, and they are soft, and as a rule very suitable for crushing. After lithotrity cystoscopy is again needed to see that the bladder is completely clear.

If, on the other hand, the surgeon proposes to open the bladder, cystoscopy will be only a supplementary procedure, and will often not be undertaken. Where, however, the shadow is excentric or fixed it is well to seek the explanation by cystoscopy.

The examination cannot be carried out in the presence of a stricture. It may fail in prostatic hypertrophy, owing either to the calculus being covered by the median lobe or to inability to introduce the cystoscope. These two conditions may, of course, be aetiologically related to the presence of the stone.

TECHNIQUE

If the urine is clear and the stone not very large, the examination is easy and the calculus can scarcely escape detection. Frequently, indeed, on introducing the metal shaft for the purpose of irrigation, one feels the click of the instrument as it strikes the stone, and the diagnosis is made or confirmed. Yet it is remarkable how long one can sometimes look into a bladder containing a calculus without seeing it. The reasons are threefold:—

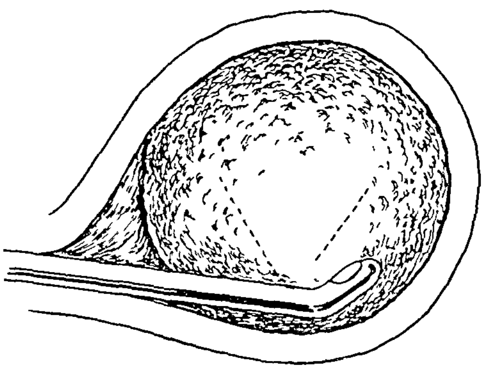


Fig 126.—Cystoscopy in a case of large vesical calculus

1. The instrument drives the stone before it to the fundus of the bladder and holds it there so that movements of rotation can be carried out without bringing it into view.

2. The shaft of the cystoscope is introduced into the bladder above the stone with its beak upwards, and as it is turned over to investigate the base of the organ, it rolls the calculus away from that area.

3. The stone lies in too close apposition with the window, so that the lamp does not light the segment to which the prism is applied. This difficulty is more evident in the case of large calculi.

Large calculi occupy so much of the bladder cavity that only a lateral crescent of the viscus is available for the cystoscopy (*Figs.* 126, 127). The stone rests on the bladder bottom and is probably in

contact with the urinary meatus The bladder is probably contracted and the stone towers up above the cystoscope when that instrument occupies the primary position It is obvious that it cannot be seen by turning the prism downwards Therefore let the window face the pubes and, manœuvring it towards one side of the bladder look along the edge of the stone It is very easy to get the window so

Fig 12 —Margin of stone shown in *Fig* 1[illegible]

applied to the surface that nothing can be seen (as described above) Large stones are often infected and covered with a coat of fibrin pus muco pus etc The inevitable friction of the instrument dislodges some of it and clouds the bladder medium impairing visibility

EXAMINATION OF THE BLADDER

The examination will investigate the (1) *Composition of the calculi* (2) *Number* (3) *Size* (4) *Position and mobility* and (5) *Presence of concomitant lesions* such as cystitis ulceration prostatic hypertrophy diverticula etc

1 The Composition of the Stones —The composition of the stone is judged by its appearance Seen through the cystoscope this differs but little from that of the stone when removed from the body Most stones are composite but having one component in excess they assume the characteristics of that type They may be primary or secondary Of these the former exist in an uninfected bladder the latter in a septic one A bladder containing a primary calculus may become infected and the stone become covered with a layer of phosphates when it will take on the appearance of a secondary calculus

Uric Acid and Urate Stones—These are generally rounded, oval, or flat, fairly smooth or slightly nodular, and vary in colour from a fawn or pale yellow to a light brown (*Plate XI* A) They may be small or of medium size, but are occasionally very large.

Oxalate Calculi.—Such stones are very easily distinguished (*Plate XI* B and *Fig* 128). They are usually single, and rounded or flattened. They are less likely to grow to large size than any of the other varieties,

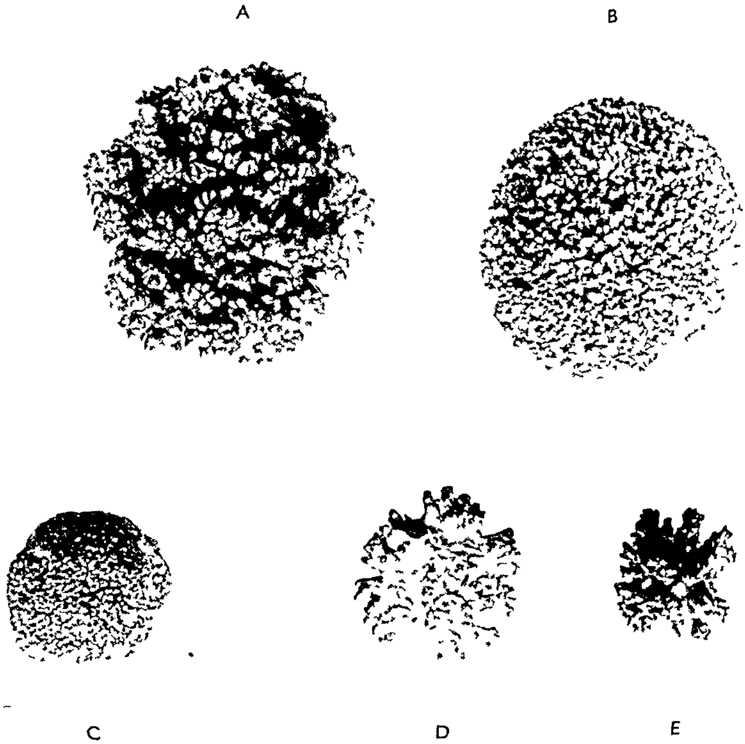


Fig 128—A group of oxalate (mulberry) calculi The two upper stones (A and B) are of unusual size, being $2\frac{1}{5}$ in by 2 in and 2 in by $1\frac{1}{3}$ in respectively The pale colour of D is due to a superficial deposit of phosphates (sepsis), and a very early stage of the same process is seen on B C is a 'white oxalate' stone, the photograph, however, makes it appear darker than the original E is a small craggy specimen

though I have removed one that was $2\frac{1}{5}$ by 2 in Crystals of pure calcium oxalate are colourless, as may be seen in some brightly glistening examples (*Fig* 128 C), and of old these were known as 'white oxalate' stones (Swift Joly) to distinguish them from the commoner 'black oxalate', whose deep colour is due to pigment adsorbed from urine and blood Stones of intermediate colour, fawn, yellow, or a rich dark brown, are also quite frequently seen Oxalate stones have uneven surfaces Sometimes this irregularity takes the form of flattened bosses (mulberry calculus, *Fig* 128), at others the exterior bristles with spikes (star calculi—jack-stones, *Figs.* 129 and 130)

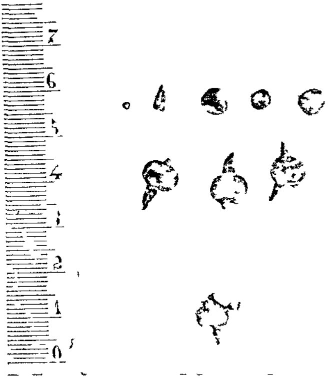


Fig 129 — Jack stones or star shaped calculi — eight from one patient one from another Note the process of budding

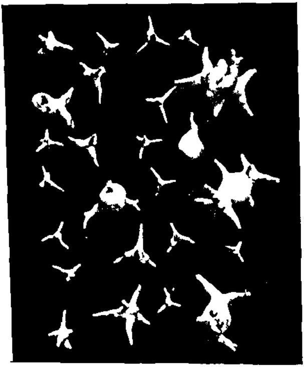


Fig 130 — Star calculi from prostatic sump (*Natural size*) Ninety two stones were counted 52 being spiculated and 40 small round and faceted Some discomfort but no pain

(*Dr Bullon s case*)

The oxalate calculus, by reason of its hardness and irregularity, gives rise to more prominent symptoms—pain, hæmorrhage, etc.—than do the others.

Phosphatic Calculi.—Calculi composed of triple phosphates occur in bladders infected by the urea-splitting group of organisms, and evidence of cystitis will be seen (*Plate XI* C). The stones are white in colour, somewhat glistening, smooth or granular, frequently multiple, and often attain a very large size. They may fill the whole bladder. They are rounded or flat when single, but when multiple they become faceted. Shreds of inflammatory deposit often adhere to them, and they may be completely encased in a thick membranous caul which hides the stone proper. Such stones are generally soft and are suitable for crushing when not too large, not fixed, and not complicated by severe cystitis or urinary obstruction. Phosphatic calculi occasionally become stained by various extrinsic agencies; thus blood pigments give them a brown colour; when silver nitrate has been in use for vesical irrigation they acquire a deep brown or metallic appearance,

PLATE XI

A, Uric acid calculus. B, Oxalic stone. C, Small phosphatic stone. D, Fragments of calculus after litholapaxy. Slight bruising of mucosa. E, Numerous calculi behind prostate. F, Two large calculi in retroprostatic pouch. Slight trabeculation of vesical wall.

whilst I have seen a greenish-blue stone whose colour resulted from the taking of proprietary pills containing methylene blue.

The colour of many stones seen in the bladder is modified by the bright lamplight reflected at close quarters, the browns and fawns becoming paler and the yellows approaching white.

If the various types of stone are gently tapped with the end of the cystoscope, it will be noticed that an oxalate calculus, being very hard, gives a bright ringing note; a phosphatic stone, being soft, produces a dull note; and the uric acid variety an intermediate one.

Other Varieties of Calculi.—Cystin, xanthin, indigo, and other rare stones are occasionally seen. *Plate VII* A, page 172, illustrates two blood stones following severe hæmorrhage from a papilloma.

2. The Number of the Stones.—This is very variable. Usually not more than three or four are found. As many as four or five hundred may be present (Thomson-Walker). *Plate XI* E shows a prostatic recess filled with a large number of calculi which are partly visible over the edge of the median lobe. In this instance 67 calculi were counted. It is not always possible to judge the number of stones present by the cystoscope, as will be evident from looking at

PLATE XI

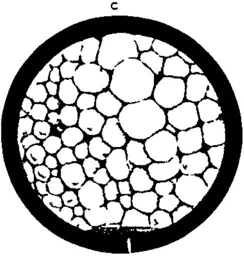
VESICAL CALCULI

A

B

C

D



E

F

the above mentioned illustration where some of the calculi are buried under others This is true also when stones are of larger size than those shown in the illustration One must often be contented with saying that several calculi are present

The shape of multiple stones varies with their consistency When soft and phosphatic they are faceted when hard they are generally round Several small phosphatic stones may fuse into a single large one the latter soon assuming a rounded shape as in a case watched by the writer Larger stones have also been known to coalesce Such stones, if sectioned will show multiple nuclei each with its own set of concentric laminæ surrounding it

3 **The Size of the Stones**—It requires considerable experience to judge the size of objects through the cystoscope In the case of a stone it is easier to rely on the radiograph than on the cystoscope though the former generally exaggerates the size to some extent The dimension of the cystoscopic image varies of course with the approximation of the fenestra to the stone as will be readily understood from *Figs* 11 and 12 page 13 and *Fig* 15 page 15 The small stone in *Plate XIII* D page 338 came out of the ureter shown in *Plate XIII* C Its actual size when withdrawn from the bladder by Bigelow s evacuator is represented in *Fig* 131 Size may be estimated by comparing that of the stone with other bladder structures as for instance the trigone or by noting the definition of the bladder wall when the cystoscope is held above the stone If the object can easily be encircled in the cystoscopic field it is quite small When only a small segment of an obviously large sphere is seen or when there is great difficulty in manipulating the cystoscope the stone is undoubtedly large

Fig 131 —Actual size of stone seen in *Plate XIII* D page 338

Kneise adopted the following ingenious ruse Using a catheterizing cystoscope he paid out into the bladder an amount of catheter equal to the focal length of the objective At this distance (canonical distance) objects should appear twice their natural size (Chapter II) He brought his catheter tip into contact with the stone and accepted the measurements then presented to his eye as double the actual size of the stone This method however gives results which are only approximately accurate as will be understood from a consideration of *Fig* 16 and its related text (page 16)

4 **Position and Mobility of the Stones**—A calculus may be free in the bladder or fixed

Free Stones —The position of a movable calculus alters with that of the patient It gravitates to the lowest point of the bladder

which is near the outlet in the upright attitude, but in recumbency is retrotrigonal. As the patient is recumbent at the cystoscopy the stone will be found behind the interureteric bar. Much of the bladder irritation will, on the other hand, be found anterior to this, in the situation which is occupied by the stone in the ordinary sitting or standing position.

Fixed Stones.—These are anchored in some one situation generally in a diverticulum, in the lower end of a ureter, or behind the prostate. Very large calculi occupy so much bladder space that they may be considered as relatively fixed. In some cases they are actually firmly wedged, and a conical prolongation may extend into the urethra (*Fig.* 132). Such stones are, of course, unsuitable for cystoscopy. Alternatively they may be primary in the urethra and fungate into the bladder.

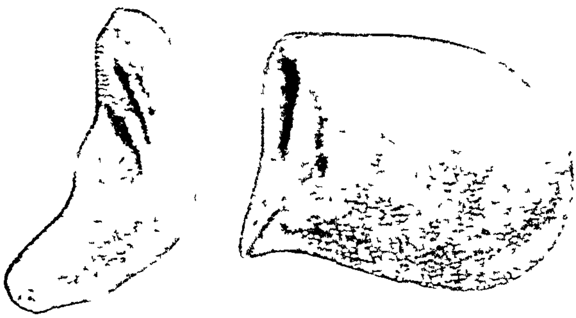


Fig. 132.—Vesical and urethral stones which articulate.

Stones in Diverticula (*see also* page 161 and *Figs.* 94–97.)—These may be single or multiple. They may be small and occupy the deep portions of the recess where they cannot be seen cystoscopically, or they may fill the whole cavity, when the presenting part becomes visible. Occasionally they protrude through the aperture into the bladder. Being constricted by the edges of the opening they then assume the shape of a dumb-bell. Only the vesical portion will be visible cystoscopically. Its intradiverticular component will be demonstrable by a radiograph taken at a suitable angle (*see Figs.* 96 and 97, page 162). Generally the vesical projection does not occupy the lowest point of the bladder, and it is fixed. It cannot even be moved with the point of a ureteric bougie, and so arouses suspicion. Similarly a radiographic shadow occurring in an eccentric position demands cystoscopic inquiry. A stone has been observed fixed in the lower end of a patent urachus (Dykes).

Prostate.—Fixed stones also occur behind the prostate. They may be hidden if the gland is very large. Here they are often multiple (*Plate XI* E and F). Urinary stagnation and decomposition are the predisposing causes. *Fig.* 133 shows twelve stones which rested on the upper surface of a very large gland, the shadow therefore occupying an unusual position.

Ureter.—Stones in the lower end of the ureter are recognized by their position, the history of ureteric colic, and the œdematous

orifice which surrounds them like a collar (*Plate XIII* C, page 338) Their treatment will be discussed in Chapter XXI

5 Concomitant Vesical Lesions—These include cystitis prostatic hypertrophy, and diverticula Of these the two latter are sufficiently dealt with already In addition new growths are observed on rare occasions In countries where bilharzial disease is prevalent vesical stones are very common being formed around masses of bilharzial tissue (*see* page 145)

Cystitis—Cystitis is an invariable accompaniment of vesical stone It may be an aseptic process dependent upon the irritation of the foreign body or it may be a septic one With *primary* stones there is generally no sepsis in the first instance The inflammatory reaction which results from the irritation and pressure of the calculus is confined to the base (basal cystitis), where in the upright position the stone rests It may go on to ulceration, though this is seen with difficulty through the cystoscope There is no formation of purulent membranes and the urine is sweet At any time organisms may be introduced and determine the deposit of phosphates on a part or the whole of the calculus When infection occurs it may be spontaneous or instrumental The cystitis spreads to the whole surface of the viscus (universal cystitis) but is still most acute at the seat of the stone When it is severe thick felted purulent membranes form in the bladder cover the calculi and mask their outline The urine becomes putrid and ammoniacal and examination may be rendered difficult on account of the vesical irritability In this way a stone which at first belonged to the primary category may take on a coating of white or yellowish phosphates and look like a *secondary* one

Fig 133—One rounded and 11 *faceted* bladder stones The diffuse shadows lying just behind the symphysis pubis are due to multiple small stones in an enlarged prostate

Frequently however the cystitis precedes and is the determining factor in the formation of the calculus either singly or in combination with urinary stagnation The stone is then always of the phosphatic type

LITHOTRITY

At the close of a *lithotrity* it is customary to wash and refill the bladder and to examine it for debris and uncrushed portions of stone. In this way we ascertain whether the organ is clear or not and therefore whether the operation is complete *Plate XI* D, taken during a lithotrity, shows some partially crushed fragments on the bladder

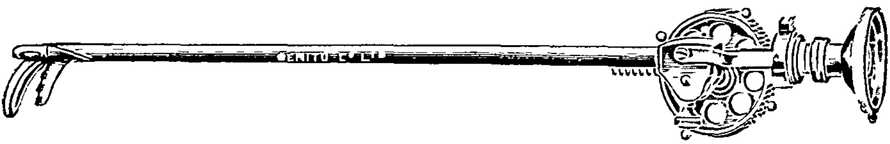


Fig 134 —Canny Ryall's cystoscopic lithotrite

floor As seen here, there are generally a few small blood-clots and the mucosa is a little bruised Very occasionally it may be necessary to postpone the cystoscopy when bleeding has been more severe, but the examination is extremely important and should, if at all possible,

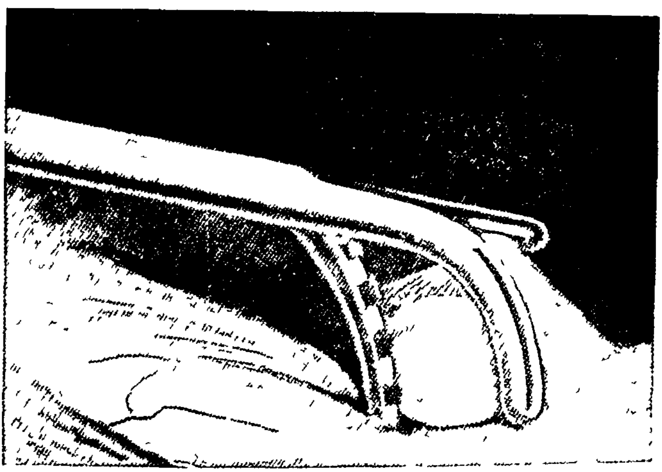


Fig 135 —Canny Ryall's cystoscopic lithotrite grasping a bladder stone under inspection

be carried out, otherwise fragments and occasionally whole calculi are very likely to be left behind All fragments of any size come away with the wash, but minute dust-like particles are generally to be seen adhering firmly to the mucosa and they are not easily removed They may safely be ignored as they will be passed naturally A fresh cystoscopy after a week is usually uncalled for, but would probably show the bladder free of foreign material, and a considerable, perhaps complete, recovery of the mucosa

Some septic bladders are regular stone factories and when cleared re-form calculi again and again. Periodic inspection may be useful in such cases by finding a stone whilst still small enough for evacuation or easy crushing.

Certain instruments may be employed for the seizing and crushing of calculi under inspection. Canny Ryall's cystoscopic lithotrite (*Figs* 134, 135) was designed for this purpose. It should be remarked that it is less powerful than the ordinary lithotrite, as its shaft is hollow for the accommodation of the telescope. It must therefore be used with discretion and a recognition of its limitations. The cystoscopic rongeur (*see Fig* 102, page 176) is less suitable than the above-mentioned instrument but may be used to break up stones which are very soft and friable, particularly phosphatic ones (*Fig* 136). It should not be employed for harder ones, as the jaws might bend and be difficult to extract from the bladder. Those who are experienced in the use of the ordinary lithotrite will prefer that instrument to these more complicated ones, as it is more generally serviceable and less fragile. Lithotrity is an operation in which the rigidity of the instrument is the first consideration.

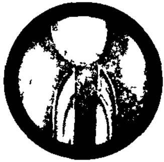


Fig 136.—Jaws of cystoscopic rongeur approaching a small friable calculus

CHAPTER XIII

FOREIGN BODIES IN THE BLADDER

The diagnosis of a foreign body in the bladder may be made by X rays, the cystoscope, or by the history of its introduction—surgically or otherwise. When a foreign body is opaque to the rays it ought to be discovered before the patient is cystoscoped. In other instances that examination will be undertaken in the investigation of urgent and painful micturition, pyuria, and, in general, symptoms suggestive of cystitis The foreign body will be found *unexpectedly*

Modes of Entry of Foreign Bodies.—Foreign bodies may reach the bladder in four ways the urethra, the ureter, by perforation of the walls of the viscus, and by surgical interference Packard *investigated* 222 reported cases, and found that in 108 the object was part of a *surgical instrument* Such may have been introduced by the urethra—for instance, the broken end of a catheter (*Plate XIII* E. page 338), bougie, or de Pezzer's tube, or the flexible guide of a urethrotome

When the instruments have been employed in the treatment of a stricture it may be found impossible to pass the cystoscope for their investigation Again, the foreign body may have gained access by a suprapubic wound—a swab or a piece of rubber drainage tubing, for example. Before their danger was recognized, silk sutures were often found acting as nuclei for the deposit of salts A row of small calculi thus formed might be seen along the line of a bladder incision Nowadays the use of absorbable suture material has obviated this risk, though stones are still sometimes seen when silk used in gynæcological operations has perforated the bladder

The writer recently gave to the Royal College of Surgeons two almost identical stones which came from the bladder of a woman who had had an anterior colporrhaphy. The stones had formed around silk sutures and were hard, uninfected, primary calculi That part of the suture which had originally protruded into the bladder cavity had collected a thick covering of salts the size and shape of a hazel-nut The part which had lain in the tissues of the vesico-vaginal septum was thinly coated and the outline of the knot was clearly visible, the whole of the stone resembling a lady's satchel with a small hole intervening between the handle and the bag A hole in a bladder stone or any urinary stone is very unusual

Foreign bodies *introduced by the patient* reach the bladder by the urethra They are much more commonly found in the female owing to the greater ease of introduction though they are far from being unknown in the male They are employed either in an effort to provoke erotic sensations or in a misdirected attempt to produce abortion The usual article is a hairpin though ordinary pins and needles wires straws thermometers glass rods a tooth brush handle matches pencils a bit of wheat pieces of wax and tallow and many other objects have been recorded Slippery elm is one of the commonest foreign bodies In view of its property of absorbing water and swelling it has a reputation amongst women as an abortifacient and is of course introduced into the bladder in mistake for the cervix I have removed a number of pieces of slippery elm of various sizes at different times all of them grossly infected and covered with phosphates (*Fig* 137)

Foreign bodies *passing through the walls of the viscus* are not uncommon Bullets shrapnel etc are frequently observed in war time arriving there either by direct hit or occasionally by subsequent abscess formation and rupture into the organ Fullerton in the first world war met with 53 gunshot wounds of the bladder In 33 the missile was retained in the body in 10 of them surprisingly enough within the bladder itself Portions of clothing not infrequently accompany a foreign body When the track passes through the bladder and the bony pelvis it occasionally leaves a sinus between the two through which sequestra may be persistently shed into the bladder over a period of months or years I have seen this several times Such sequestra unless passed are almost certain to form the nuclei of stones Legueu in the first world war saw 32 bladder wounds Ten produced stones and in all of these cases there was an associated injury of the bony pelvis

Pointed articles—for instance needles surgical and otherwise—occasionally perforate the bladder *Plate XIII* F page 338 shows the tip of a hatpin which is just visible through the vesical wall The patient had been stabbed near the umbilicus by a hatpin which, breaking off had been lost Bladder symptoms developed some considerable time later and when investigated cystoscopically were attributed to the presence of the tip of the pin which was found to have perforated the bladder near its apex Judd has reported a similar case the foreign body in his patient being the end of a 'jack knife' Objects which had presumably been swallowed have been removed from the urinary bladder reaching the viscus by ulceration (Freeman Harrison Ballenger and Elder Young Roberts) and sequestra from a tuberculous hip have been removed from that organ (Judd Sadek) *Fragments of* bone from a fractured pelvis also occasionally penetrate the bladder

Cystoscopic Examination.—On cystoscopy the article is easily recognized. but the appearance which it presents supplies an interesting lesson in the optical properties of the cystoscope. Magnification and distortion are more readily appreciated when everyday objects are viewed In many instances the surgeon will know the size of the object because he is familiar with its appearance outside the body

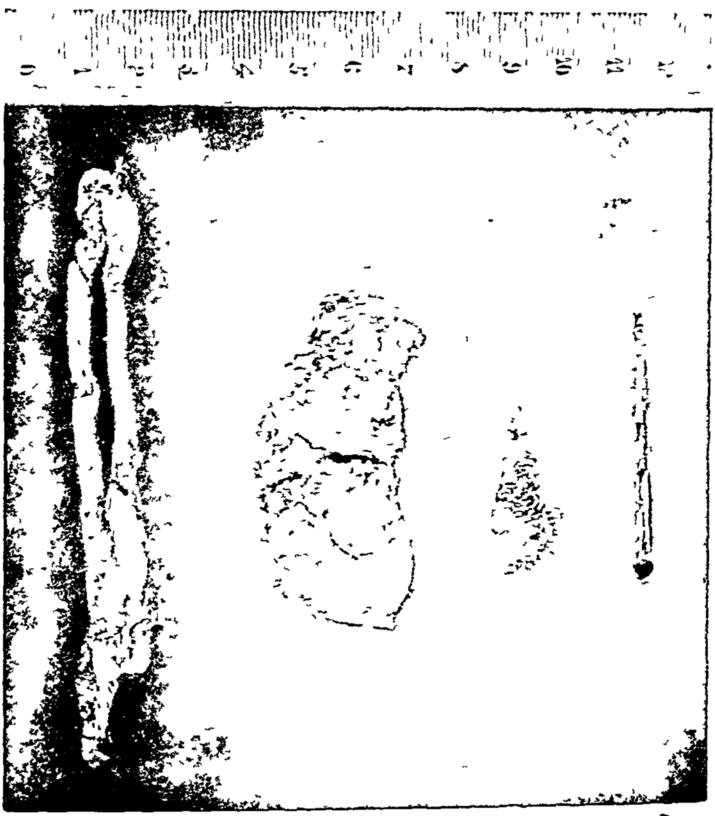


Fig 137—Foreign bodies from bladders A, Taper from male bladder Introduced by patient when intoxicated and pushed in by a second taper Floated in vault of bladder Recovered by cystoscopic rongeur, bite of which may be seen at upper end Its lower end is knotted B, Slippery elm buried in phosphates Introduced about the fifth week of pregnancy as an abortifacient Removed by suprapubic route late in pregnancy C, Phosphate covered needle D, Hair slide from the bladder of a girl aged 7½ years Removed by operating cystoscope Slight incrustation

He will realize the more clearly how difficult it may be to estimate the size of a growth or stone through the cystoscope More important however, is it for him to form an opinion of the extent of phosphatic incrustation with a view to deciding whether extraction through the urethra is feasible The size of the foreign body itself offers an obvious scale against which the deposit can be measured Lengthy foreign

bodies must be examined bit by bit They cannot be seen in their entirety

The position occupied by the object varies with its size and length When small it lies in the retrotrigonal area but when long it is accommodated transversely or obliquely Flexible bodies such as catheters or urethrotome guides may become tied in knots (Thomson Walker *see also Fig* 137 A) Paraffin chewing gum and other foreign bodies lighter than water will be found in the region of the air bubble until they become coated with urinary salts and sink to the bottom It is apically that they must be sought with any instrument which may be chosen for their removal as was the case with the taper shown in *Fig* 137 A

Infection is usually introduced with the foreign body but occasionally it may be absent for a long time Eventually it is inevitable It leads to urinary decomposition and the deposit of phosphates on the article a part or the whole of which is covered thereby As a rule however sufficient remains visible to allow the diagnosis to be made those portions which are exposed to friction being especially liable to escape When completely covered the curious shape of the object may arouse suspicion If the cystoscopist and radiologist both fail to recognize the nature of the nucleus, the foreign body may be regarded as an ordinary stone and the attempt made to crush it The mistake will be discovered either by the unaccustomed sensation imparted to the touch by the foreign body or by the cystoscope when that instrument is used towards the end of the litholapaxy (page 226)

The extent of phosphatic deposit will vary with the degree of the cystitis the length of time the foreign body has lain in the bladder and also with the material of which it is made In some authentic instances foreign bodies are known to have remained in the bladder at least fifteen years The longer they have been present the more marked will probably be their incrustation Phosphates, however adhere to some substances more readily than to others Zuckerkandl states that wax does not become coated at all silver is slow whilst iron rubber and vegetable substances are quickly covered The absence of incrustation on wax has also been noted by Sherman and others but that it is not always immune is shown by H Turner who found a nucleus consisting of a cylinder of wax in the interior of a huge stone which he had removed from a man s bladder The wax had been introduced three years previously Baldwin has reported a similar case the patient being a woman and the nucleus consisting of tallow It was known that the tallow had been in the bladder for only a few months Swift Joly says that soft paraffin used as a catheter lubricant may remain in the bladder indefinitely with no deposit on the surface but that hard paraffin soon becomes coated

The urine may become ammoniacal and fœtid, and the bladder too irritable to tolerate cystoscopy. Ulceration is common, especially near the ends of lengthy articles but it is usually hidden by the interposition of the foreign body. Perforation occurs occasionally.

Treatment.—The cystoscopist must decide whether removal shall be by suprapubic operation or per vias naturales. Many foreign bodies which have found an entrance through the urethra may be induced to retrace their steps. Severe cystitis and a contracted bladder indicate open operation. When the object is deeply encrusted with salts it should not be withdrawn through the urethra.

Soft objects, such as catheters or straws lying free in the bladder, may be withdrawn by the lithotrite. The cystoscopist should note

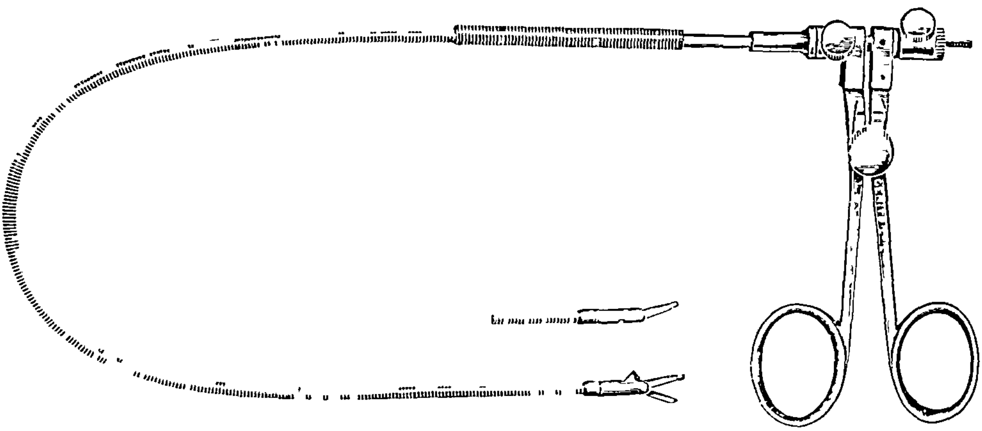


Fig 138.—Buerger's forceps

beforehand their situation so as to be able to seize them quickly, and also the extent of their incrustation. The cystoscopic lithotrite (*Figs* 134 and 135, page 226) or rongeur (*see Fig* 102, page 76) may also be employed. I have known a broken catheter to be spontaneously evacuated.

Certain *hard* objects, such as hairpins, wires, etc., may be withdrawn by some form of operating cystoscope. The forceps shown in *Fig* 138 is serviceable for this purpose, and may be employed through a Swift Joly or Buerger instrument. Prior to seizing it with the forceps the foreign body should be brought into line with the urethra. To accomplish this the vesical distension should be as great as the circumstances will reasonably permit, and an ordinary ureteric bougie should be employed to manœuvre it into position. If the foreign body has one end more rounded than the other, that end must lead. These manipulations are performed through the Joly or Buerger instrument as the case may be and the bougie is then gently removed and replaced by the forceps, the cystoscope remaining in situ. When

the foreign body has been grasped satisfactorily it is withdrawn through the sheath, the whole of the catheterizing and optical parts being removed in order to make room for it. If, owing to its shape, length or size, the foreign body refuses to enter the sheath the surgeon must decide whether it is wise to remove the cystoscope retaining his hold on the foreign body and withdrawing it gently after the instrument or whether it is better to resort to suprapubic operation. This decision will be made on the knowledge which he has acquired of the size, etc., of the foreign body.

Other instruments capable of grasping and withdrawing objects found in the bladder are the cystoscopic rongeur and Canny Ryall's cystoscopic lithotrite. They are much more powerful in the jaws than the one just described. By them portions of phosphatic deposit may be chipped away under inspection so as to reduce the size of the foreign body sufficiently to permit withdrawal. The author has found the cystoscopic rongeur the most practical of all these various instruments.

The exponents of direct cystoscopy would remove foreign bodies from the female bladder through the straight endoscopic tube. The patient occupies the lithotomy position with the head of the table lowered. When the tube is introduced the bladder distends with air owing to the gravitation of the abdominal contents in the direction of the diaphragm. A head lamp illuminates the vesical cavity, and a pair of alligator forceps passed through the tube is used to seize the foreign body, which will be found in the vesical fundus. The method requires practice, and most operators will nowadays prefer the indirect or prismatic instrument.

CHAPTER XIV

URETEROCELE. URETERIC PROLAPSE

URETEROCELE

This condition is stated to be present in 2 per cent of cystoscopic examinations (O'Connor) It has been known under several different titles, such as 'ballooning of the ureter', 'cyst of the ureter' etc The name 'ureterocele' is probably the best The term 'prolapse

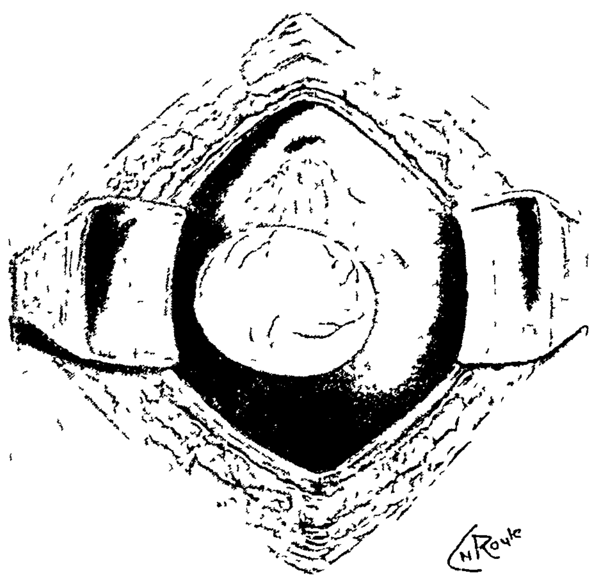


Fig 139 —View of ureterocele at operation Note the small orifice of the ureter situated to the inner side of the cyst, and compare it with the size of the right ureteric orifice

of the ureter' has also been applied to it, but should be reserved for the condition described at the end of this chapter *Plate XII* C and E, page 272 give a good impression of the appearances presented cystoscopically, and *Fig* 139 that seen when the bladder is opened

The underlying factor in the production of this condition is the smallness of the orifice of the ureter, which is usually a mere pin-point. This appears to affect the mucous coat only (*Fig* 140) The cyst is produced by mechanical distension A quantity of fluid brought

down from the kidney by the peristaltic wave of the ureter impinges on the inadequate orifice and balloons a double layer of mucosa into the bladder cavity. The repetition of this process brings about progressive dilatation of that part of the conduit which has no external muscular support—the intravesical termination—but it acts similarly if less effectively on other sections producing ureteric and pelvic distension.

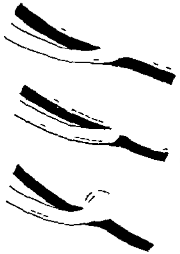


Fig. 140.—Schematic representation of the evolution of a ureterocele. *a*, Opening of normal size. *b*, Pinhole aperture in mucosa opening through muscular layer is of normal size, theoretical condition in early life before onset of ballooning. *c*, Early ureterocele.

In most of the reported cases where microscopic examination has been made the cyst wall has been found to consist of two layers of mucosa, a vesical and a ureteral (*Fig.* 141) back to back with a small amount of intervening areolar tissue. In very few has muscular tissue also been present. The remaining coats of the ureter and the pelvis of the kidney are dilated, as I have proved by noting cystoscopically the wide mouthed orifice left after operation and by pyelography (*see also Fig.* 143). Dilatation has also been seen in post mortem specimens and severe hydronephrosis is sometimes encountered.

The cyst is bilateral in about 10 per cent of cases. Other congenital abnormalities are occasionally present both in the bladder and elsewhere. Faulty insertion of the ureter is often observed. Hurry Fenwick reported 15 cases in which the intravesical ending of the ureter had been noted. In 9 it was double on the side of the cyst and in these cases the cyst was connected with the ureter which received a faulty insertion in the trigone. This ureter drained the upper third of the corresponding kidney, which portion was usually found to be hydronephrotic from back pressure (cf. pages 401 et seq.). Many subsequent papers confirm this association with a double ureter. In one case I found a strongly marked remnant of the urachus at operation. In some cases the condition has been associated with such deformities as cleft palate and hare lip (Caulk). These associations are evidence of a congenital origin,

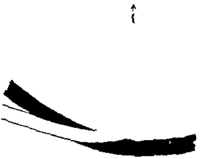


Fig. 141.—Diagrammatic representation of a ureterocele.

a view which is further supported by the fact that ureteroceles have been seen in the newborn. Riba made the interesting discovery of bilateral ureteroceles in identical twin sisters an observation which likewise points strongly to a congenital origin All the ureteroceles which the present writer has seen have been regarded by him as undoubtedly congenital

Stones complicate these cysts in a large proportion of cases Goldberg found them 5 times amongst 22 cases, O'Connor in 4 out of 19 and Hellstrom in 5 out of 7 patients They may be composed of any of the usual constituents and may be single but are frequently multiple Their customary situation is within the sac but they are not uncommonly found in the ureter or kidney. Their existence has been erroneously adduced as an argument in favour of the acquired origin of ureteroceles it having been thought that they were an aetiological factor in the production of the cyst by causing stenosis which led to dilatation The origin of stones in a true ureterocele is not difficult to understand as in addition to stagnation there is a very minute orifice so that a flake of solid material which would normally escape is held back to become the nucleus for a stone The stone therefore is a secondary phenomenon whereas in the false ureterocele (*see* page 240) it is the primary factor and the dilatation of the terminal ureter is secondary

Symptoms.—The condition may be completely asymptomatic when the ureterocele will be found unexpectedly if a cystoscopy is undertaken for any purpose If symptoms are present they may be of vesical or upper tract origin and aseptic or septic Dealing with the *aseptic* group in the first instance, *lower* tract symptoms will generally be absent until the cyst has grown sufficiently to make contact with the vesical outlet Once this has been established obstruction to micturition incontinence, pain and hæmorrhage are liable to occur Their cause will be unexplained apart from cystoscopy Occasionally the cyst has presented itself at the external meatus in the female (*Fig* 142) In precystoscopic days this was the way in which the condition became known A number of such cases are on record many of them young children one being only thirteen days old At first the prolapse tends to return to the bladder spontaneously on the patient's lying down This has been known to go on for as much as twenty years (Emmett and Logan) Later the impaction persists and the sac wall becomes red, bleeding, and œdematous , it is infected and in some instances ulcerated or gangrenous It may resist reduction Naturally obstruction to micturition is severe Some ureteroceles have been snipped off by gynæcologists, who have not recognized the condition with which they have been dealing. Two instances of this occurrence have come

within my own knowledge and another is reported by Furnival. In the male the cyst may get similarly impacted in the urethra but this is less easily recognized and there are fewer instances on record.

Upper tract symptoms may precede vesical symptoms and are caused by renal distension. They will be increased if the cyst gets caught in the urethra and will probably then concern both kidneys.

When *infection* occurs cystitis and pyelitis superimpose their own picture on the above and greatly increase the discomfort of the patient. Meredith Campbell says "Ureterocele ... was observed in 1 in 30 cases of chronic urinary infection in children." It is notable that

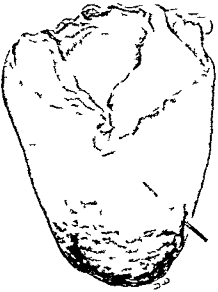


Fig 14.—Operation specimen of ureterocele from a female. It prolapsed down the urethra causing retention and presented externally. The dark area at the apex shows the exposed portion. Bristle in orifice.

failure to identify ureterocele in the young sometimes accounts for premature death. For this reason the true incidence of the condition is doubtless actually less in adults than in the young. In the severer grades hydronephrosis and pyonephrosis completely destroy the kidney and may necessitate nephrectomy or ureteronephrectomy.

Cystoscopic Appearances.—With the cystoscope a translucent cyst is seen rising from the position of one or both ureters. It may be circular or oblong, is narrow at its origin and swells out above. It consists of healthy mucous membrane which when thin is semi-transparent and in which vessels are to be seen coursing outwards from its attachment towards its summit. Occasionally the cyst itself may be covered with smaller translucent cysts (Thomson Walker). In the case from which *Plate VII* E was taken the orifice of the ureter could not be brought into view as it was situated at the apex of the

cyst in a position to which the fenestra could not be approximated, it is, however well shown in *Fig* 139 which was drawn at operation on this patient, and there its diminutive orifice contrasts strongly with that of the opposite side, which is normal In many patients the minute orifice, which is situated more favourably, can be seen (*Plate XII* C). It is visible as a rule when the cyst is small, but less often when it is large and is rarely visible on the largest cysts Indigo-carmine may be used to locate it A thin, prolonged, comparatively forceless jet is characteristic, and as the cyst collapses the jet tails off Many orifices are posteriorly placed and cannot be seen The present writer's experience is that the opening will not admit a bougie or catheter, but not a few authors claim to have used dilatation as a means of treatment and for retrograde pyelography

Ureteroceles swell up slowly and rhythmically whilst under observation as the ureteric wave brings down fresh fluid to them and then collapse again. In one case I distended the bladder with 12 oz of lotion, hoping thereby to get a more complete view of the ureterocele The result was different from what was anticipated I found that the cyst had collapsed under the extra pressure and lay like a flaccid bag on the bladder base When a certain amount of fluid was withdrawn and the intravesical pressure was thus reduced the cyst recovered its distended condition The distension or flaccidity of the cyst appears therefore to be a resultant between the bladder pressure and the intra-ureteric pressure Probably the observation that some cysts fill up gradually whilst being watched, and then collapse again, is explained by the bladder pressure happening to be approximately equal to that within the ureter It seemed to me that if I had met with the cyst in a collapsed condition on the first occasion I might have failed to make a correct diagnosis Very large cysts may likewise give rise to diagnostic difficulties because they tower above the fenestra as a large surface clothed with healthy vesical mucosa The unusual shape of the viscus and the absence of a ureteric orifice will help to establish a diagnosis Cysts so large as this will however already have made contact with the vesical orifice and have caused some disorder of micturition The example illustrated in *Fig* 142 had passed down the urethra and had presented at the external meatus causing retention of urine The whole cyst wall is thickened and that portion which had passed beyond the external meatus is red and velvety. These changes were easily recognized at cystoscopy

Urography.—*Excretion* urography provides a means of demonstrating a ureterocele radiographically as the contrast fluid is temporarily detained within the cyst To get a satisfactory picture the bladder should be empty, or nearly empty and it is therefore a good plan to use an inlying catheter Several plates may have to be exposed

to ensure catching the cyst at a time when it is distended *Fig* 143 is a sketch from such a radiograph and exhibits the rounded contour of the cyst and the dilatation of the corresponding ureter and pelvis

Retrograde urography is capable of showing a pretty filling defect of the bladder but it is questionable whether this adds anything useful to the knowledge gained by cystoscopy, which is by far the more important procedure Excretion urography can on occasion serve the same purpose This, of course, depends on the cyst containing little or no contrast fluid and therefore on the associated kidney's poor capacity, the opposite kidney being responsible for the good concentration in the bladder itself

Treatment —The treatment selected will depend on the size which the ureterocele has reached Large ureteroceles are best removed by open operation when they will be snipped off close to their attachment to the bladder wall with a pair of curved scissors Small and moderate sized ureteroceles can be successfully dealt with by cystoscopic means The cyst is burned by means similar to those employed in the treatment of a papilloma *Plate XII D* page 272, shows the cyst depicted in the preceding picture after partial destruction It takes a length of time for the burned tissue to separate during which the drainage of the ureterocele should occur through its natural orifice Great care must therefore be exercised that this opening be not sealed by the electrode It is as a matter of fact so tiny that any trifling œdema even such as is produced by the electrode applied at a distance is capable of closing it and so producing complete ureteric occlusion It is unnecessary to diathermize the cyst widely the objective is adequate drainage and a small aperture will accomplish this and will not threaten the patency of the existing orifice by rendering it œdematous *Plate XII D* page 272 betrays an excess of zeal which should not be imitated A small dependent puncture is better practice The cyst subsequently tends to shrivel and unless it is of unusual size does not impede micturition or otherwise cause trouble Should the condition be bilateral the two sides must not be treated at the same sitting Recognition of this danger is particularly important because it is one which is likely to be overlooked

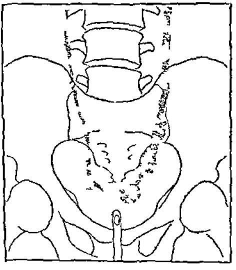


Fig 143 —Sketch made from a urogram in a case of ureterocele

These manifestations were little developed in the specimen depicted in *Fig* 147, but there was severe infection in the case from which *Fig* 148 was drawn The projection rarely exceeds three-quarters of an inch in length and it protrudes into the cavity like an everted coat sleeve, the large terminal opening being patulous and visible A catheter tip will engage in the opening, but is immediately held up by the firmly impacted stone The condition is quite unmistakable, the non-translucent mucous membrane, the steep, parallel, sausage-shaped sides, and the patulous terminal opening bearing no resemblance whatsoever to the more delicate ureterocele, with its rhythmic ebb and flow On removal of its cause a prolapsed ureter recovers its natural state Thus a patient who presented a large and tumid ureteric eversion was re-examined by me three months after the removal of his stone, when the prolapse was found to have receded and the meatus was indistinguishable from the normal

CHAPTER XI

FISTULA OF THE BLADDER

INDICATIONS FOR CYSTOSCOPY

Cystoscopy is not indispensable for all fistulæ of the bladder. Those which occur to the skin (e.g. suprapubic fistulæ), the vagina (vesico-vaginal fistulæ) or the uterus (vesico-uterine fistulæ) result in the loss of urine to the surface and are self-evident, so that little fresh information is likely to be required from cystoscopy. The two last

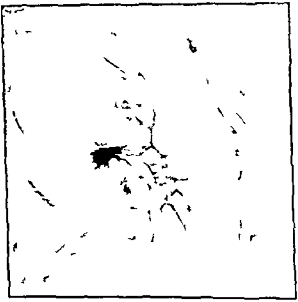


Fig. 149.—Bladder opening of a vesico-sigmoidal fistula.

mentioned, namely, vesico-vaginal and vesico-uterine fistulæ, however, need differentiation from such fistulæ as lead to the ureter and not to the bladder (*see below*).

Fistulæ taking place between the bladder and the neighbouring hollow viscera are moderately common and call for cystoscopy. The large intestine is implicated much more often than any other structure, the order of frequency with which its various sections are involved being the sigmoid (*Fig.* 149), rectum, appendix (*Fig.* 150), cæcum and

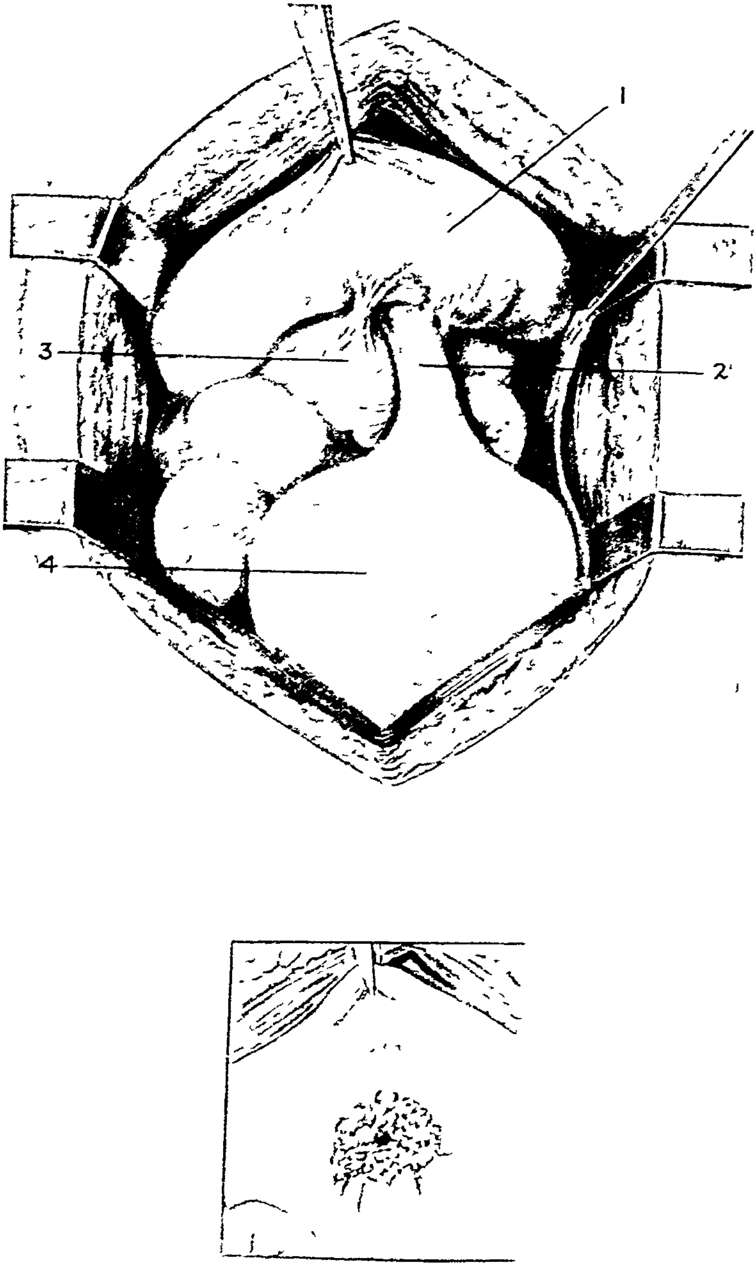


Fig 150 —Vesico appendicular fistula due to rupture of an inflamed appendix into the bladder 1, Bladder, 2, Appendix, 3, Thickened meso appendix, 4, Cæcum *Inset* View of bladder opening after separation of the appendix

transverse colon.* Diverticulitis and carcinoma of the colon between them account for almost all fistulæ between the bladder and colon and of these diverticulitis is definitely the more frequent. Telling and Gruner reported that in more than 12 per cent of 280 cases of diverticulitis the gut showed direct adhesion to the bladder. With many fistulæ, however, there is an intervening abscess cavity or a track of some length lying surrounded by intestines or omentum. Other organs involved are the Fallopian tubes (simple or tuberculous salpingitis) and the small intestine.

Abscesses draining into the bladder, though not truly fistulæ, are conveniently considered under this heading. Of these may be selected for mention the peritoneal suppurations (appendicular, tubal, etc.) and psoas abscess, whilst prostatic and vesicular suppuration (especially tuberculous) may find an outlet into the bladder, leaving a gaping fistulous opening in or near the trigone. The lesion responsible for any given fistula may prove to be either inflammatory or neoplastic, but it is rarely primary in the bladder itself, as few of the diseases of that organ show any disposition to perforate to the skin or to an adjacent mucous surface.

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* Harrison Cripps, in his classical monograph (1888), gives the following figures: Rectum 25, colon 15, small intestine 12, colon and small intestine 5, not stated 6 (total 63).

Pascal (1900) collected 190 cases of vesico-intestinal fistula and showed that the rectum was involved 113 times, the colon (principally the sigmoid) 42 times, the ileum 26, the appendix 7 and the cæcum twice.

Sutton (1921) produced statistics of 59 entero-vesical fistulæ and gave the following distribution:—

	Cases	*Per Cent*
Vesico-entero-vaginal	1	1.69
Vesico-entero-rectal	1	1.69
Vesico-appendicular	3	5.08
Vesico-utero-rectal	3	5.08
Vesico-rectal	3	5.08
Vesico-ileal	13	22.03
Vesico-cæcal	1	1.69
Vesico-sigmoidal	34	57.6

The fact that the fistula involves a third organ in not a few cases will be realized from Cripps's and Sutton's tables. Of the last mentioned group of 34 vesico-sigmoidal fistulæ 21 had a single aperture in the gut, but in 5 *there were multiple* openings into the sigmoid itself, whilst 8 cases showed the complication of an opening into a third viscus, the third organ being the ileum in 4 *instances*, the ileocæcal angle twice and the rectum twice.

The difference in the incidence of rectal perforations is striking. The last series probably reflects the value of cystoscopy *in the diagnosis* of fistulæ of the lowest sections of the gut and also our modern knowledge of sigmoid diverticulitis. Cripps, indeed, remarks the frequency *with which inflammatory* lesions were responsible for fistulæ and the correspondingly good prognosis, pointing out also the remarkable fact that a *rectal carcinoma* but rarely perforates into the bladder (7 times in 63 *collected fistulæ*). Probably some of his and Pascal's rectal fistulæ were really sigmoidal.

FISTULÆ TO INTRAPERITONEAL ORGANS

When an adjoining inflammatory process involves the vesical wall there is a prodromal period of vesical irritation which is unexplained. Should an abscess burst into the bladder, a quantity of pus is discharged with the urine, following which a generalized cystitis develops and leads to an aggravation of the bladder symptoms. When the fistula is of the vesico-intestinal variety, flatus and fæces may be passed with the urine. The passage of flatus per urethram (pneumaturia) is an arresting phenomenon which the patient rarely overlooks in giving his history. It is almost pathognomonic, quite rarely having any explanation other than that of a fistula communicating with the bowel (*see*, however, cystitis emphysematosa, page 96) The *flatus escapes at the end of micturition* because the gas occupies the bladder vault and is thus the last of the bladder contents to be expelled. It makes a gurgling or spluttering noise, and bubbles sometimes form momentarily at the external meatus. The gas expelled may smell fæcal. If the patient reports pneumaturia the surgeon should seek the opportunity of witnessing it, but the chance may not offer as the symptom is intermittent, and in many cases occurs only occasionally, depending on the state of the bowel

Fæcal material in the urine can be recognized by the naked eye or by the microscope, and the urine has a characteristic odour. Grape seeds and other foreign particles are sometimes recognizable in the urine. When the fistula is very low down the large gut the fæces are solid and so may be passed through the urethra with difficulty or even block it completely. Strangury and obstruction may result, though the urine itself generally passes back into the intestine and so escapes. The passage of urine per anum is a recognized sign of an entero-vesical fistula, but is absent or inconspicuous when the fistula is small If urine is present in quantity it may be taken to signify *a free communication.*

The fistulous opening is usually quite small but it may reach the size of a two-franc piece (Adams). If large, the fistula allows the bladder contents to escape immediately and the resulting collapsed bladder is unsuitable for cystoscopy. With the customary small fistula cystoscopy is easy, but the fistula itself is generally difficult to identify because of its minute size, though its position may be suspected on account of the severe hyperæmia bullous œdema, and the plicæ which surround it (*Plate VI* D, page 152). This area of swelling, however, is of small extent—usually about the size of a sixpence or a shilling —the remainder of the bladder merely showing cystitis of greater or less degree though in a few instances it is completely free from inflammation Centrally placed in the suspected area may sometimes be seen a tag of slough, pus, or fæces which betrays the actual

situation of the opening, and in many instances pressure applied at an appropriate spot in the hypogastrium will cause the escape of pus or other foreign material into the bladder through this central spot, which escape may be seen through the cystoscope and clinches the diagnosis

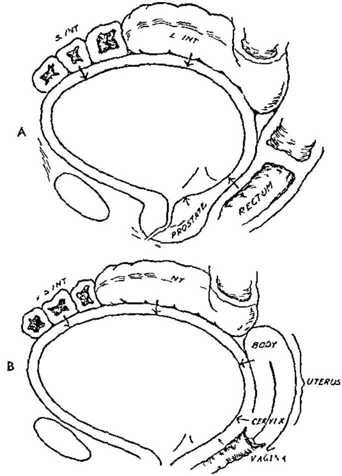


Fig 151 —Relationship of the bladder to various neighbouring organs illustrating some sites at which fistulous communication may take place A Male B Female

The situation of the fistula depends on the bladder's relationship to extravesical organs (*Fig* 151) The important group of fistulæ which lead to the intraperitoneal viscera are necessarily limited to the peritoneum covered part of the bladder and are therefore to be observed in the retrotrigonal area and on the posterior and lateral walls My personal experience is that with great regularity they give the impression of being high up on the posterior wall near where it meets the roof of the bladder though other writers have seen them

frequently in the ureteric region The left side of the bladder contains the fistulous opening three times as often as the right because of its relationship to the sigmoid

A ureteric catheter can sometimes be passed through the fistulous opening, and opaque solution, such as a 10 per cent solution of sodium iodide, may be syringed through the catheter into the bowel In this way a good radiograph of the bowel may be obtained and the section which is involved may on occasion be identified Sometimes one may even be fortunate enough to recognize the features of the responsible pathological condition—diverticulitis, carcinoma etc In a few instances the fistulous track between the bowel and the bladder is long and tortuous, and this fact may be diagnosed pre-operatively by injecting the sinus Fistulous tracks of this type generally result from an abscess developing between the two organs and rupturing into both

The nature of the responsible lesion, whether inflammatory or neoplastic is not likely to be discovered by the cystoscope Intestinal carcinomata are very advanced before they present within the bladder and even then their appearance is not characteristic The nature of the primary lesion may be disclosed by a barium enema but otherwise it remains obscure until operation and even then it may, at first sight, be uncertain This is unfortunate for the aetiology determines not only the prognosis, but also, in many cases, the desirability of interfering at all

SUPRAPUBIC AND VESICO-VAGINAL FISTULÆ

Fistulæ to the skin of the suprapubic region are in a different category from those leading to internal organs, as they are easily discovered cystoscopically, Old fistulæ, in particular, are epitheliated, pale, and smooth, and show little or none of the œdema which characterizes so many vesico-intestinal and other internal fistulæ.

With *vaginal fistulæ* of any size the bladder contents escape into the vagina during lavage A large fistula is discoverable by vaginal palpation or by a speculum and may be occluded for the purposes of cystoscopy by a finger or a tampon These openings are placed in the bladder base and appear like irregular crypts showing epithelialization when old and varying grades of bullous œdema Occasionally a stone fills the fistulous opening and may show channels for the escape of urine (*Fig* 152)

Vesico-vaginal fistulæ require to be differentiated from uretero-vaginal fistulæ The former may in favourable cases be identified by cystoscopy, but when small are found with difficulty. A useful ruse is to fill the bladder with some easily recognizable fluid such as indigo-carmine, and any escape of the bladder contents will stain

a tampon placed in the vagina to receive it This examination is open to two fallacies (*a*) Even when the fistula opens into the bladder the fluid does not invariably appear in the vagina as a small opening

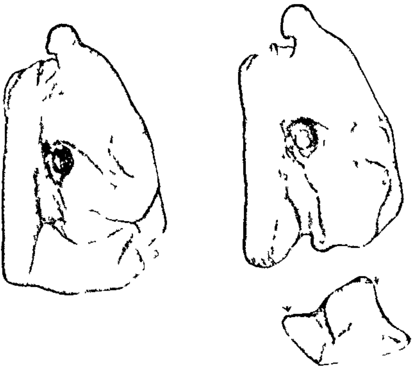


Fig 159—Stone occupying a large vesico vaginal fistula Note grooves *into* which fitted the edges of the fistulous opening and hole by which urine escaped

or a narrow tortuous track may temporarily prevent leakage (*b*) That there may be ureteric regurgitation and a return of the fluids through the fistulous ureter

CHAPTER XVI

A MISCELLANY OF BLADDER CONDITIONS

LEUCOPLAKIA

THE lining of the urinary tract is called a transitional epithelium because, though stratified, it displays little tendency under ordinary circumstances to keratinize or become horny In some conditions, however, it is capable of doing so and the result is a leucoplakia Leucoplakia is more often seen on the mucosa of an ectopic bladder than elsewhere presumably because of friction against the clothes, and in this situation it has afforded useful opportunities for study

Leucoplakia of the normally placed bladder is a rare disease. Its cystoscopic features were first described by Brik in 1896 Comparatively few cases have been reported, and some of those found in the literature are not very convincing It is, however, a well-recognized condition, and is probably commoner than the meagreness of the records would indicate The writer has seen two definite cases, one of which had undergone malignant degeneration (*Plate VIII* F, page 180) In the other the lesion was recognized at operation, having been overlooked at cystoscopy It seemed to him that, just as ichthyosis linguæ is best demonstrated when the tongue has been dried so the corresponding condition of the bladder may escape observation because it is seen through fluid and especially when, as often happens, there are other manifestations of cystitis present

Leucoplakia is generally regarded as a sequel of long-standing irritation (Nitze, etc) In most cases this is so and cystitis or stone is present to account for it However, Marchand has reported a case of extensive leucoplakia of the urinary tract at the age of 7 years, and Leber one in which the renal calices showed a similar lesion at 4 months, so that some other aetiological factors must exist Kretschmer showed that the fourth decade of life is the one in which the incidence is heaviest (27 per cent)

Cystoscopic Manifestations.—The leucoplakic patch resembles the corresponding lesion of the tongue It is grey or silvery in colour, and is generally smooth in surface, but is occasionally corrugated In one or two reports the epithelium has been seen desquamating in thin flakes making the surface rough In no reported case have cracks or fissures, as seen in the tongue been recorded Blood-vessels

are not seen being completely hidden by the proliferated epithelium The edges of the patch are sharply defined and demarcated from the surrounding hyperæmic bladder wall It is little or not at all raised though the central portion may be elevated to some extent The outline is extremely irregular, and its margin may be scalloped or dentate

Position—All parts of the bladder seem to be affected indiscriminately, the trigone (Lichtenstein) neck (Halle) upper anterior surface (Krebs) etc having been involved Once leucoplakia was found in a diverticulum (Czerny) In each of my own cases the base was the only region affected

The *number* of patches varies but is usually inconsiderable though Lohenstein reported a case in which there were numerous plaques near the trigone The *size* also varies The patch may be quite small—2 or 3 mm —and may easily be overlooked, but in several instances the entire bladder has been involved (Ravasini etc)

Other Lesions—

Cystitis—The rest of the bladder is occasionally healthy but as a rule cystitis of greater or less severity is present and is looked upon as a predisposing cause it is usually of the chronic variety Healthy mucosa or an area of hyperæmia may surround the patch of leucoplakia and the latter may contrast strongly with its pearly white appearance Papin however denies this and says that the absence of an areola serves to distinguish the plaque from an ulcer of the bladder covered by a false membrane When there is much muco purulent deposit on the bladder base it may hide the thickened epithelium or the latter may remain unrecognized because of its similarity in colour and general appearance to the muco pus

Calculi and Trabeculation—These are frequent concomitants (Albarran)

Malignant Degeneration—In one of my patients a red elevated nodule which appeared to resemble an epithelioma was found A portion of it was removed with the operating cystoscope and was found microscopically to be epitheliomatous Malignant degeneration has also been reported by Marion

The leucoplakia is not always limited to the bladder In some instances one or both ureters and renal pelves have been involved and the kidney dilated and infected The ureter may be strictured (Verrière Kretschmer) Sometimes the process originates in the upper tract and spreads to the lower It may arise in a tuberculous kidney (Beer)

Diagnosis—The diagnosis is made cystoscopically the patient suffering from symptoms of cystitis in which pain is unusually prominent (cystitis dolorosa) As before pointed out leucoplakia may be overlooked when there are false membranes on the vesical

they become somewhat purplish within a day or two and slightly mottled. Subsequently they pass through the various colours familiar to all as any extravasation fades, till in about two or three weeks all signs of the disease have completely vanished. Sometimes recurrent extravasations occur, and if they follow each other quickly, lesions at different stages may be observed in the bladder. The mucosa covering the petechiæ is intact and healthy. Stevens and Peters excised portions by means of a cystoscopic punch and showed the mucous membrane to be normal and unbroken, with blood-cells in profusion lying in the submucous tissues There was no leucocytic infiltration or anything else suggesting an inflammatory lesion. Blum claims to have seen ulceration of the overlying mucosa but this observation is not confirmed by other urologists

Diagnosis.—In the absence of a generalized purpura, vesical purpura requires to be differentiated from hæmorrhagic cystitis as the two cystoscopic appearances may easily be confused. Symptomatically also there is some similarity between them, as each gives a certain amount of 'ardor urinæ', though this is generally more marked with a cystitis of such severity as to be hæmorrhagic, than it is in purpura. Many purpuric cases exhibit general malaise, headaches muscular weakness, and an irregular pyrexia which are liable to be attributed to a pyelocystitis. Cystoscopically the chief distinguishing feature is the appearance of the mucosa between the patches. In purpura it is completely normal and healthy, retaining its sheen and showing no undue vascularization In this it contrasts with a hæmorrhagic cystitis where the membrane intervening between the extravasations is dull and inflamed in most cases intensely so (*see Plate III* B, page 80, and also page 80 itself) In cystitis there may also be a deposit of mucus or muco-pus which is not seen in purpura The bladder capacity, which in cystitis is reduced may likewise be diminished in purpura, but as a rule it is unaltered The presence of pus and organisms in the urine in cystitis is a further feature serving to distinguish these two conditions, both being absent from the urine in purpura It should be remembered, however, that the purpuric bladder is unduly susceptible to infection, and that this may arise either spontaneously or as a result of cystoscopic instrumentation Once it has put in an appearance both the cystoscopic and the clinical pictures are dominated by it and the purpuric origin of the illness may be masked. Trauma in the form of operative treatment of the bladder itself or of other pelvic structures may produce purpura-like lesions These are to be seen particularly after vaginal operations and childbirth The history, naturally, gives a clue to their cause They are, as a rule transitory, but this is true also of the purpuric lesion proper

VARIX

Small tortuous veins in the submucosa which are unworthy of the dignity of this title are not uncommon They occur in the region of the trigone and bladder neck but are also to be seen in the body of the viscus A true varix is rare, in fact its existence has even been denied Varices were first observed by Viertel and have been described by Pean, Bazy, Albarran and many others An example is shown in *Plate VI* C page 152 The site of election is the neighbourhood of the neck trigone and retrotrigonal area, they are never seen in the upper part of the organ They may occur either in the male or female but are much more frequent in the latter, especially during pregnancy When varices occur in the bladder they are generally also seen elsewhere, especially on the vulva legs, and anus Hæmaturia from this source sometimes occurs (Guyon Baraduc etc) but is rare It may be very profuse and necessitate suprapubic cystotomy (Casper) It is often assumed that a urinary hæmorrhage during pregnancy has its origin in a varicose vein but this is an unsafe assumption and the possibility of overlooking a neoplasm should invariably lead to the recommendation of early cystoscopy though if the patient is already near term it should be postponed till the termination of the pregnancy In cancer of the uterine cervix varices are not uncommon, and according to Barringer result from venous engorgement caused by adherence between the growth and the bladder wall In men they are seen most commonly as a complication of prostatic hypertrophy In either sex they may be observed in the neighbourhood of large vesical or extra vesical tumours

The appearance of the blue tortuous vessel is scarcely mistakable It is never extreme in its development and usually not more than three varices are found They never give rise to symptoms with the exception of hæmorrhage and their discovery is merely a cystoscopic incident

MALAKOPLAKIA

Ever since Hansemann (1903) discovered malakoplakia [μαλακο soft—soft plaques] at a post mortem and gave the first accurate description of it sporadic cases have been reported and in all about fifty are now on record many of them having been found post mortem The following account of a case they had seen is by Thomson Walker and Barrington —

On cystoscopy there was no difficulty in getting a clear medium The whole of the mucous membrane of the bladder with the exception of the trigone and a small area behind this was strewn with yellow plaques which varied in size from a very small point to an area the size of a threepenny piece Viewed from a distance the colour was yellowish pink but on closer inspection it was pale yellow

of spinal syphilis (mostly tabetics) in which he had seen the condition Previously Barrington had observed similar changes caused by transsection of the cord in the cat From the time of Burns' article onwards there is practically no further English or American literature on the subject On the European Continent six examples of funnel-neck bladder, all occurring in subjects suffering from various diseases of the central nervous system, were reported by Schramm (1920), and the Germans, disregarding preceding publications, have christened the condition 'Schramm's phenomenon'.

ANATOMY OF BLADDER CLOSURE

Fresh ideas have been advanced recently regarding the trigonal muscle, and if they prove to be acceptable our views on the physiology of micturition must be modified Till recently it has been taught

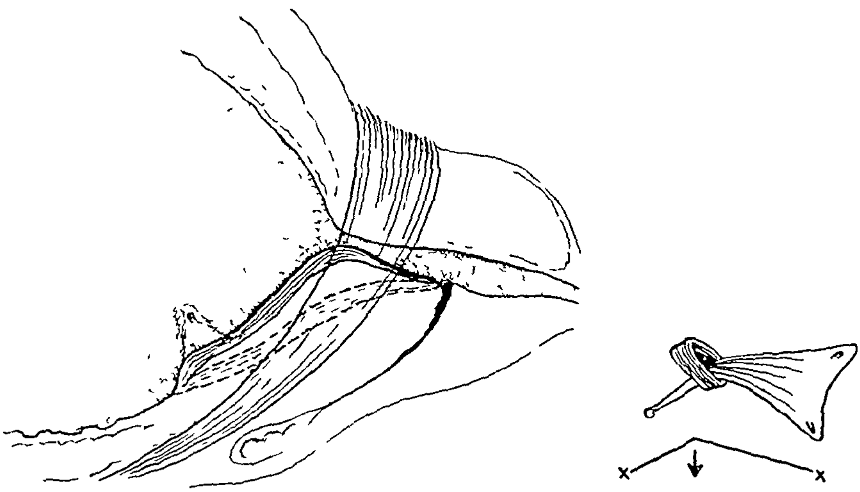


Fig 154 —Sagittal section of bladder neck to show the trigonal muscle at rest and in contraction (dotted line) (*Modified from Young*)

that at the onset of urination the internal sphincter undergoes an 'inhibitory dilatation' comparable with that seen at the anus According to Young and Wesson, however, the trigonal muscle, superficially placed in reference to the other muscles of this region, passes downwards and forwards through the internal sphincter to receive an insertion near the verumontanum (*Fig* 154) Its course between these two points is not in one plane, the vesical and urethral sections forming an angle, which angle corresponds to the internal meatus of the bladder and lies at the uvula vesicæ In contracting the trigonal muscle straightens out this angle and drags down the lower lip of the vesical orifice Those muscular fibres which run circularly round the urethra are dragged open, and urine passes into the posterior urethra

The trigonal muscle has however been shown by my colleague McCrea to be but a thin sheet whilst the internal sphincter is a very definite structure so that if the trigonal muscle has the function which Young and Wesson ascribe to it a relaxation of the sphincter must accompany the trigonal contraction. Many elastic fibres situated in the region of the internal sphincter appear to play a part in the closure of the bladder neck. Perhaps the sphincter itself relaxes but the trigonal muscle is responsible for dragging it open together with these elastic strands.

The writer has drawn attention to the fact that the trigonal muscle as a result of its triangular shape acts not only in a backward but also in a transverse direction (*Fig* 15). The two bars of Bell converge on the internal meatus and as they start the urethral section of their course they change their direction and run side by side down that tube. In contraction these two muscles straighten out and so exert lateral in addition to downward pull on the meatus thus opening it transversely as well as vertically and giving the orifice a triangular shape in cross section. The appearance presented by the manifestation under discussion would be satisfactorily explained if the sphincter fibres were paralysed and this may be provisionally accepted as the anatomical basis for the condition.

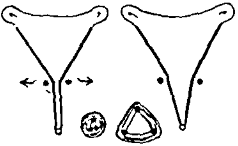


Fig 1 —In action the divergent limbs of the trigone open the meatus in a transverse direction

The funnel neck bladder must not be confused with an appearance which has much in common with it but which arises from a quite different cause. In prostatic hypertrophy the growth of the lateral lobes produces a deep cleft like urethra at the bottom of which if the cystoscope is held at a suitable distance the floor of the passage, together with the verumontanum can be clearly seen. The two conditions are easily distinguished from each other by the different appearances of the vesical meatus which are described in the appropriate places.

IMPORTANCE AND FREQUENCY OF THE SIGN

There is little doubt that this sign is frequently met with in disease of the central nervous system and that when encountered it is strongly suggestive of such disease. Many observers including the writer have seen the characteristic hiatus in subjects who were not at the time known to be suffering from any nervous lesion but who on closer examination were found to give evidence of such disease

Some, indeed, amongst these cases have not presented any further symptoms or signs even on the most careful investigation, but have developed tabes dorsalis or other trouble at a subsequent time a funnel-shaped neck having sounded the first warning of its approach It may thus be the initial sign and is frequently an early development On the Continent some neurologists refer doubtful early cases of tabes etc. to the cystoscopist for confirmation

This symptom important and common though it is has attracted surprisingly little attention in this country, as also in America and France The few available papers come from Germany and Russia, but the views expressed in these papers are so contradictory that it is difficult to gather from them any real idea of the value of the sign

From amongst studies *attributing* diagnostic significance to the funnel-neck deformity of the bladder may be selected for quotation that of Epstein Juschelevsky, and Michelson partly because it contains the largest series of patients (500) as yet examined Two hundred of these patients were known to be sufferers from central nervous affections the remainder being the ordinary cystoscopic material of the writers' clinic This investigation appears to have established the fact that the phenomenon depends not so much on the type of the disease, as upon its localization The majority of cases showed lesions of the spinal cord, though in brain disease it was found that if both cerebral hemispheres were involved the sign might be positive Lesions of the peripheral nervous system do not produce it In spinal injuries the writers found the sign present in 90 per cent of the cases in tabes in about 84 per cent, and in syphilitic myelitis in 83 per cent Cases of spina bifida, though not numerous in their series, showed a high percentage of affected sphincters, and it is interesting that a few patients in whom the sign was positive and yet no nervous disease was discoverable were found by X rays to have some clinically unrecognizable degree of spina bifida These observers hold that it is doubtful if a funnel-neck is ever discovered in completely healthy men and they think that it is likewise questionable whether it occurs in purely functional disturbances of the central nervous system without any anatomical substratum In true organic disease of the central nervous system—all varieties taken together—it was absent only in about one-third of the cases which they examined

Several other articles express comparable views (Otto Schwarz, Perlman, et al) Some authors indeed, produce a higher percentage of cases showing the sign than do the above writers, and Halperstein says that in tabes 100 per cent of cases are affected Of these writers some think that neurasthenics may exhibit a hiatus

There are not wanting however those who *deny* any value to this phenomenon foremost amongst whom is Oswald Schwarz By this school it is maintained that —

1 The sign may be absent in unmistakable nervous disease which is indeed admitted (*see above*) though it is hard to see why this should detract from its importance when present

2 Overfilling of the bladder is said to produce a hiatus in normal people It has been shown above that the first phase of normal micturition is the opening of the bladder outlet by the trigonal muscle in a way which will produce an appearance identical with a pathological hiatus Overdistension of the bladder causes spasm of the trigonal muscle and opening of the sphincter at the same time provoking a call to micturition In fact it produces a physiological hiatus which differs from the pathological one only in being transient passing off when over distension is relieved The overfilling which brings it about is unnecessary and undesirable and does not occur if a proper technique is employed (*see* page 51)

3 The symptom is present on one occasion and absent on another or it comes and goes during a single cystoscopic examination

4 The longer the cystoscope is in the bladder the more likely is the phenomenon to present itself and if the ocular end of the instrument is unsupported its vertical drag will cause a dilatation of the meatus so that a hiatus is artificially produced

5 Sacral anaesthesia is said to be responsible for the occurrence of a hiatus On theoretical grounds this would appear not unlikely the inhibition of the internal sphincter leading to its dilatation just as sacral anaesthesia can produce dilatation of the anal sphincter and so lead to incontinence of feces The innervation of these two muscles is similar

Some of those who refuse to allow any diagnostic value to this sign have found it positive in a very much smaller percentage of cases than do its upholders Thus Dunajewsky and Michejew examining 42 cases of tabes found it present in but 16 6 per cent which contrasts strangely with the figures previously quoted showing 84 to 100 per cent To explain this discrepancy it must be remembered that the dilatation is not always equally developed and that the slighter degrees are easily overlooked Moro indeed has tabulated four grades (*Fig* 156) which show respectively —

1 Radial streaking in the region of the inner bladder opening and the gradual transition of the bladder into the posterior urethra

2 The urethra and colliculus seminalis are indistinctly seen as a result of lying close up against the prism showing that the dilatation is inconsiderable

3 The field of view is dark in its proximal part but as the cystoscope is further withdrawn it enters a relatively spacious

spindle-shaped chamber, in which the illumination is bright. On the floor of this chamber the colliculus is clearly seen together with its surrounding valleculum.

4. The condition is fully developed (*Figs.* 153 and 156 4). The bladder neck gapes widely and the normal angulation at the point of transition fails. The prostatic urethra can be easily examined in its complete length

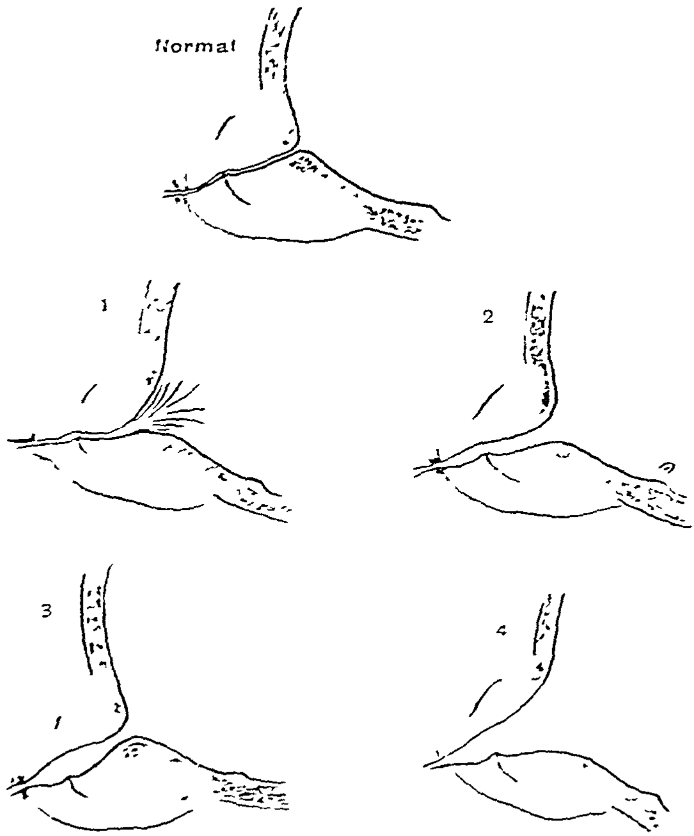


Fig. 156.—To illustrate Moro's gradings (*see text*)

That varying degrees of the phenomenon present themselves is unquestionable. In the above table, Types 1 and 2 are easily overlooked, and even Type 3 which is sufficiently distinctive, will escape observation unless the cystoscopist is actually on the look-out. These facts probably explain some of the prevailing contradictions relating to this manifestation.

In an attempt to obtain a personal view of the incidence and significance of the funnel-necked bladder Poole-Wilson and the present writer examined a series of 25 men suffering from central nervous disease. Twenty-one of them were tabetics or general paralytics and

in these two classes the phenomenon was positive in all except three patients In addition a single example was discovered in a case of disseminated sclerosis We classified our material according to Moro s gradings and soon discovered the difficulty of being quite sure of and hence the unreliability of, Types 1 and 2 Our figures refer therefore exclusively to Types 3 and 4 On many occasions we noted that by increasing the distension of the bladder a funnel would develop when not previously present or that a minor degree of funnel formation would give place to a major In the table appended this accounts for the presence of two figures attached to many of the cases

Disease and Number of Patients	Principal Symptom		Grading (Moro)
Tabes dorsalis (16)	Dribbling	7	4 4 2→4 3 3
	Enuresis		3 or 4→4
	Automatic micturition		0
	Difficulty	3	4 0 1 or 2
	No symptoms	3	4 0→4 4
	Copious evacuation of urine	3	2→4 4 2→4
G P I (4)	Incontinence	2	3 4
	No symptom	2	3 4
? Tabes ? G P I (1)	Sensation of distension without residual urine		0
Disseminated sclerosis (3)	—		0 0 3
Spastic paraplegia (1)	—		0

To obtain a good view of the verumontanum is the best test of the sign and to do so the ocular end of the cystoscope must be steeply depressed between the patient s thighs otherwise the condition escapes observation It is only the inferior wall of the urethra which comes into view by this examination for if the cystoscope is rotated the field becomes dark as soon as the side walls are approached and even by manœuvring the instrument we have never been able to get a proper view either of the lateral or upper boundaries of the canal

In addition to the patients referred to above all of whom were known to be suffering from some form of nervous disease we have examined the records of 171 consecutive cystoscopies *on males* in the ordinary cystoscope clinic and amongst these found 15 examples (8 8 per cent) of a funnel neck In the early part of this series of cystoscopies no special watch had been kept for funnel neck deformities and we found in our records only 3 5 per cent of examples which serves to illustrate how often they are overlooked in routine

work. Paralysis of the internal sphincter may serve as a satisfactory explanation when the condition occurs in spinal disease but when it is discovered unexpectedly a different explanation must be sought Straining to micturate may account for a few. and the fatigue of a long cystoscopy for some others. Several have been discovered in patients under spinal or sacral anæsthesia and no significance must be given to the sign unless it is confirmed by subsequent cystoscopy without anæsthesia One or two may perhaps be examples of early nervous disease. But a considerable remnant is unexplained and it appears probable that a hiatus may develop in the completely healthy man. Even if this proves to be the case and the pathognomonicity of the lesion is not established. the marked difference between the incidence of the funnel-neck deformity in health and in nervous disease is very striking The discovery of the condition calls for a complete neurological overhaul and an examination of the Wassermann reaction. etc. No cystoscopy in the male is complete until the instrument has been withdrawn down the urethra and a hiatus has been searched for. and this holds true with particular force for such cases as have obstruction. especially unexplained obstruction. as a symptom

Central nervous disease is frequently responsible for derangement of bladder function and it has been well known since the days of Romberg that dysuria may be the first symptom of various spinal diseases and particularly of tabes dorsalis When occurring as an isolated symptom its cause is likely to be diagnosed only by exclusion of other conditions. Trabeculation of the bladder of a special kind is a recognized sign of nervous disease and has certain characteristics which have been described on page 151. and which distinguish it from other types of trabeculation. Yet this trabeculation is inconstant and easily overlooked and its diagnostic significance is not completely reliable. Even though the presence of a funnel-shaped neck is probably not pathognomonic it nevertheless suggests some derangement of the central nervous system. A combination of the two conditions —a trabeculated bladder and a funnel-shaped outlet—certainly carries considerable diagnostic weight

CHAPTER XVIII

PROSTATIC HYPERTROPHY AND OTHER DISEASES OF THE PROSTATE. ENDOSCOPIC PROSTATIC SURGERY

INDICATIONS FOR CYSTOSCOPY

FROM the point of view of indications for cystoscopy the patients applying for treatment fall into two groups according to whether the diagnosis can be made by purely clinical means or not. If not the cystoscope will almost certainly be required. The proportion of patients in which the symptoms and signs are unconvincing is a fairly big one so that there is an important field of usefulness in the differential diagnosis of the complaint. The other group in which the diagnosis does not call for cystoscopic confirmation will be handled differently according to whether the surgeon's preference is for the suprapubic or for some form of perurethral operation. In the latter case a preliminary study of the vesical neck is usual.

When a suprapubic prostatectomy is proposed as the line of action—the diagnosis not being in doubt—it is always questionable whether any advantage is to be gained by cystoscopy and the writer's attitude has been to avoid it where possible as it is not entirely without danger (*see below*). This view has been further reinforced by the modern tendency to dispense with all types of instrumentation of the bladder before the operation itself so that work may proceed in an aseptic field.

In addition to those cases in which the prostate is the primary trouble hypertrophy will frequently be met with in males past middle life who come up because of unrelated disease of the urinary tract, especially for bladder growths. In that way the great prevalence of prostatic hypertrophy in this age group will be borne home to the cystoscopist and he will have an opportunity to study numerous examples of the minor enlargements which for the most part remain symptom free and themselves require no treatment.

Cystoscopy may also bring to light concomitant bladder lesions which are sequelæ of the hypertrophy but most of these can be diagnosed by other agencies as for instance stone by X rays cystitis by pyuria etc. More precise knowledge of the state of the bladder wall is not indispensable for its condition has a subordinate bearing on treatment. In general the important thing is to make a diagnosis of prostatic hypertrophy and when that has been done the decision

for or against operative interference will rest, not on the local complications, but on such things as the renal function and the general health of the patient

THE DANGERS OF CYSTOSCOPY IN PROSTATIC ENLARGEMENT

The dangers of cystoscopy in hypertrophy of the prostate are —

1. Sepsis —The possibility of infecting a bladder by cystoscopy has already been suggested and infection may prove a serious or even fatal complication The difficulty of keeping the bladder aseptic even when the greatest care is exercised may prove insuperable, especially if the urethra contains organisms, or the bladder residual urine Many bladders are already infected when first seen It is well known that these give less cause for anxiety than does the uncontaminated viscus Once they have overcome their preliminary infection they seem to acquire a degree of immunity to sepsis which renders subsequent instrumentation safer

2. Urethral Shock and Suppression of Urine.—These conditions will occasionally occur unexpectedly in apparently good subjects, but the latter is particularly likely to happen where an overdistended bladder is suddenly emptied The clinical picture in this type of case is, as a rule, so characteristic that cystoscopy is not called for

3. Hæmorrhage.—(*See* pages 272, 273)

4. Epididymitis.—This is a complication to which these patients are susceptible after instrumentation, and also following operation

5. Retention of Urine.—Retention which was probably incomplete before cystoscopy, is sometimes aggravated and may become complete as a result of the cystoscopy

PATHOLOGICAL ANATOMY

The structural alterations resulting from prostatic hypertrophy must be understood before it is possible to appreciate the cystoscopic manifestations of the disease Those which interest us are (1) *Prostatic changes*, (2) *Urethral changes and alterations of the urethral meatus*, (3) *Vesical changes* (*Fig* 157)

1. Prostatic Changes.—Adenoma formation affects chiefly that median segment of the prostate gland lying between the urethra and the ejaculatory ducts It is here that the first changes are observable, and here also that in maturity they generally become most pronounced Other parts of the organ are not, however, exempt Independent adenomata commence to grow on the lateral aspects of the urethra and as they extend establish continuity with the median group which indeed they may exceed in size and antedate in origin Anteriorly the change is less evident and is often absent The

increase in bulk of the gland occurs in part extravesically and in part intravesically

Extravesically its growth causes it to encroach on surrounding structures It is however rigidly fixed inferiorly by its attachment to the triangular ligament and anteriorly its proximity to the pubes

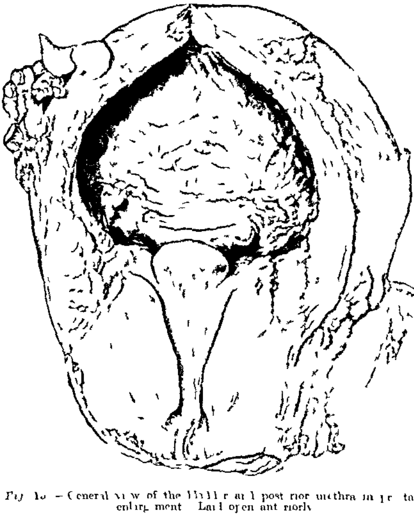


Fig 16 — General view of the bladder and posterior urethra in prostatic enlargement Laid open anteriorly

prevents advance so that the only three directions which can provide increased accommodation are posteriorly where it bulges towards or actually into the rectum laterally where it displaces the levatores ani and superiorly where it lifts the bladder base It also encroaches on and compresses the urethra

The raising of the vesical floor is important for the *outlet* which in normal circumstances occupies the lowest point is *now* situated on the top of an elevation and surrounded by a vallecula

Intravesical Changes.—But another important factor enters into the elevation of the vesical floor, and especially that of the meatus The elevation consists of adenomatous tissue covered by a thin layer of mucous membrane This came to be an intravesical structure through pushing aside the internal sphincter in such a way that this muscle, particularly in its posterior and postero-lateral parts, is divorced from the meatus At the front of the urethra, where there is little or no hypertrophic change, the muscle still retains its old position at the margin of the orifice, but as it is traced backwards

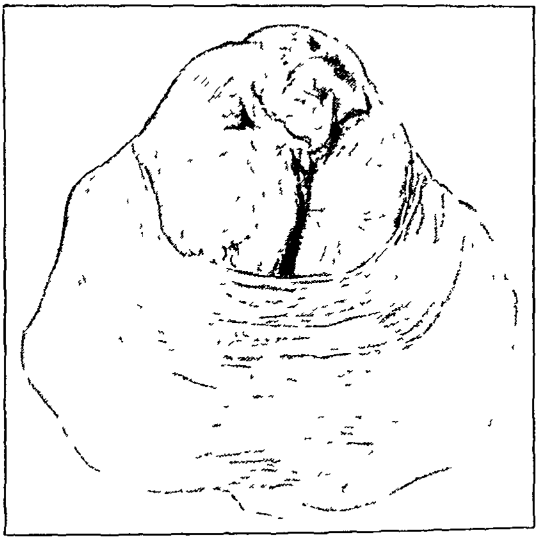


Fig 158—An enucleation specimen seen from the front The intravesical projection retains its covering of mucosa The lateral and middle lobes, and the cleft like urethra are well seen Note particularly the ribbon of internal sphincter muscle which has torn away with the gland, and observe its position close to the meatus in front, and how the lobes have pushed through the ring especially posteriorly and laterally There is a furrow on the surface of the gland where it has been gripped by the internal sphincter

it will be found to recede gradually from that opening, having been pushed away by the growing lobes of the prostate so that it now forms a band thrown round the base of the intravesical section of the prostate and dividing this off from the extravesical part (*Fig* 158)

The encroachment of the prostate on the vesical cavity and its relationship to the sphincter was difficult to explain so long as it was thought that prostatic hypertrophy originated in the body of the prostate gland itself It is now widely believed that the point of origin of prostatic enlargements is not really in the prostate gland at all but in certain glandular structures situated immediately below the mucous membrane of the trigone and urethra and known as the submucosal glands (*Fig* 159) Though these submucosal glands form a practically continuous chain it is convenient to classify them

into three groups according to their anatomical site They are known, therefore as subtrigonal subcervical and prostatic glands The subcervical group which is the most important collection lies beneath the uvula vesicae It is also called Albarran's group' because this French surgeon first showed the role it played in the production of the so called middle lobe These glands are accommodated in the submucosa and are thus internal to the muscular layer though a few of them penetrate amongst the adjacent muscular fasciculi When we realize that prostatic enlargement begins in a structure having this position there is but little difficulty in explaining the relationship to the internal sphincter which has just been described and how that muscle comes to be ousted from its customary situation at the meatus The growth arises actually within the ring of the muscle which it distends and displaces by its increasing bulk * The sphincter is eventually divorced widely from the meatus and comes to lie below the level of the orifice in a position where it functions at great disadvantage being unable either to contract or to expand freely

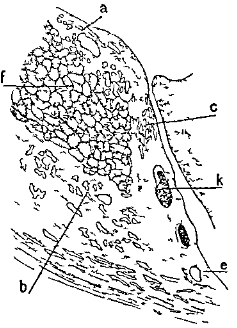


Fig 159 —Sagittal section of the urethra and bladder neck in the early stage of prostatic hypertrophy a Submucous cervical glands b Glands of the intermediate portion c Submucous urethral glands e *Urethral* mucosa f Internal sphincter k Glands undergoing cystic change (*Jores*)

The central and posterior portion of the gland is the one where change is most marked (*Fig* 160) *and from it is produced in this way* the so called middle lobe of the hypertrophied prostate A similar alteration is usually evident at other parts of the meatus especially laterally where the adenoma though less markedly, distorts the

* There is another not very rare type of hypertrophy in which the muscle is not displaced in the way described here The adenoma appears then to have sprung from those urethral gland which lie distal to the sphincter and never gaining admission to its circle they lack the opportunity to dilate it but instead lift it upwards This variety of hypertrophy is sometimes called an extravesical enlargement for the gland does not actually project into the bladder cavity as does the more common kind The cystoscopic picture is not greatly changed though the division into lobes is less in evidence and the mucosa as it overlies the sphincter is more like that of the normal neck—not so thin and vascular At a suprapubic operation the finger must dilate and pass through this muscle circle in order to enucleate the adenoma

meatus, the neoplasm here also curling the sphincteric musculature outwards The anterior region is the one least involved, and indeed there is generally no intravesical bulge at this point

The *distribution* of the hypertrophy is not constant, though when one part is affected it is customary to find a certain amount of gland proliferation in other regions Nevertheless, we speak of a middle or a lateral lobe enlargement, according as these respectively bear the brunt of the increase, Occasionally one comes across a case in which

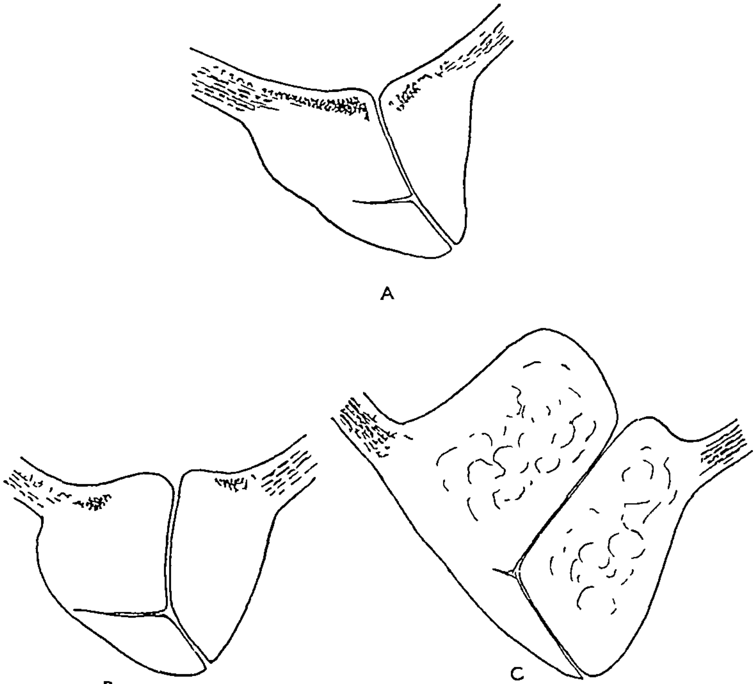


Fig 160 —A, Normal relations of vesical sphincter to prostate, etc B, C, Alterations produced at vesical neck by increasing degrees of prostatic hypertrophy

there is no evidence of increase cystoscopically, except in one lobe, and when this occurs the middle lobe is the one usually affected I have seen cases in which the lateral lobes were enlarged and the middle one quite unaffected, though this is comparatively rare The floor of the urethra is then continued into the trigone on the same plane, and by elevating the cystoscope into the cleft between the two hypertrophied lobes it can be traced backwards for a fair distance

2. Urethral Changes.—The urethra undergoes modification as a result of the changes in the shape and size of the prostate It becomes *longer* The increase is confined to that portion of the tube proximal to the verumontanum, and this section is augmented by about half an inch to an inch and a half, but when the hypertrophy is marked, it

may on rare occasions amount to several inches Obviously such an elongation would preclude the use of the ordinary cystoscope and special instruments have been made with the object of overcoming this difficulty They are however, unnecessary as so large a gland is quite rare and with so great an increase in length the diagnosis becomes self evident

The urethra becomes more *bent* There is an angle in the normal prostatic urethra at the level of the verumontanum (*Fig* 50 A page 57) This becomes increased in the ordinary type of hypertrophy owing to the development of the middle lobe (*Fig* 161) The angle may become so acute as to prevent the passage of the cystoscope or occasionally even that of an ordinary catheter It must be straightened out

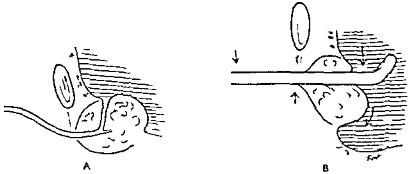


Fig 161 —A Urethra in prostatic hypertrophy Note increase in the curve of the prostatic urethra as compared with the normal shown in *Fig* 50 A page B Urethra in prostatic hypertrophy after introduction of cystoscope Mark d retroversion of prostate causing exaggeration of the retroprostatic pouch

during the passage of the cystoscope This straightening is accomplished partly by bending forward the distal but chiefly by retroverting the proximal segment Such retroversion has an effect on the shape of the bladder base emphasizing the retroprostatic declivity and making the pouch deeper and more impenetrable (*Fig* 161 B) A secondary effect of the antero posterior bending of the urethra is that the meatus comes to occupy a position which is relatively if not actually, more anterior (*Fig* 160)

A *transverse section* of the urethra also shows changes The urethra as it lies between the two lateral prostatic lobes is altered from being a small rounded tube to become deep and slit like The cystoscope withdrawn into this cleft can make visible the lower wall of the prostatic urethra as far back as the verumontanum a proceeding which is quite impracticable in the normal state (*see also* Funnel neck Deformity of the Bladder Chapter XVII) This visualization of the urethra becomes possible because the increased depth of the channel allows the lamp and prism of the cystoscope to be held at a good working distance from the floor of the passage

Quantity of Vesical Fluid.—Bladders containing much residual urine are necessarily of large size. They may have a capacity of several pints. When the viscus is catheterized it is usually possible to replace an equal amount of fluid This is, however, not invariably true An inflamed bladder sometimes contracts immediately and refuses to be re-distended to its previous extent. This should be borne in mind during irrigation, the initial washes being tentative and the increase gradual, until the measure of the organ has been taken as described on page 52

Given, then, an organ of large capacity, it must be decided how much lotion shall be employed If too much, the vesical walls will be remote and their inspection rendered more difficult If too little, the voluminous parietes will be undistended, and redundant folds may conceal some features of the bladder The relaxed mucosa also screens the musculature, and the effects of hypertrophy and trabeculation are lost, whilst the membrane itself may appear more œdematous than when seen under greater dilatation

A portion of the retroprostatic recess is usually concealed from view by the gland margins, but it varies with the degree of distension employed With more lotion the pouch deepens and one would expect it to become less visible At the same time, however, it is extended in a backward direction and the mean result is that a larger surface is displayed It is easy with the irrigating cystoscope to vary the quantity of fluid, and examine at varying distensions Start therefore with the usual 8 oz of lotion and investigate the prostatic margin and the general surface of the vesical mucosa If a satisfactory exposure of the latter is not obtained, the medium can be rapidly augmented, say to 16 oz, and a fresh survey undertaken This stratagem is valuable also when, as happens with big prostates, the ureteric orifices hide themselves behind the overhanging gland An increase in the vesical distension may bring them into view.

Examination of the Bladder.—It has been shown above that the principal object of cystoscopy in this complaint is the diagnosis or confirmation of hypertrophy The state of the bladder wall is of minor interest and would not in itself constitute a justification for the examination Begin therefore by investigating the shape of the prostatic border The instrument is withdrawn until the fenestra is flush with the meatal rim, which, crossing the cystoscopic field, commences to cut off the view of the vesical cavity. It is on the appearance and shape of this rim that the diagnosis rests.

In the normal condition of the parts (*see Fig* 59, page 65), it will be remembered that the uppermost four-fifths are concave, whilst the lowest fifth is slightly flattened, so that if the instrument is made to follow the margin by rotating it on its long axis within the lips, the

perfectly regular circular disposition of the upper four fifths and the slightly flattened or rarely convex lower fifth are easily appreciated. In the upper four fifths the edges are sharply defined and translucent because the margin is thin and sharp. In the lowest segment they are absent owing to the similarity in direction of the trigone and posterior urethra.

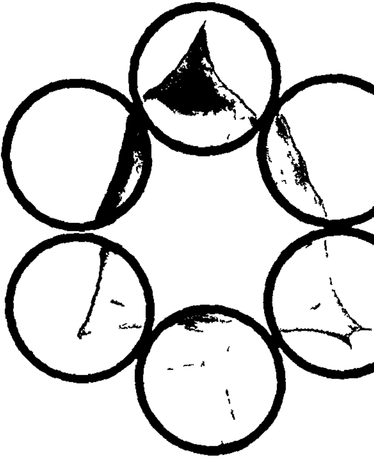


Fig 16[illegible].—Series of cystoscopic fields showing collectively the contour of the vesical aspect of an enlarged prostate. (Cf. *Fig* [illegible], *Fig* [illegible] and *Fig* 16[illegible].)

All this is changed in prostatic enlargement. The gland bulges into the meatus and throws up a rampart around it. Seen cystoscopically this rampart has margins which consist of a number of convexities separated by sulci or recesses. Rotate the instrument within the lips of the orifice and a general impression of the arrangement will be obtained (*Fig* 162). Having done this, scrutinize each segment individually. Each cystoscopic field represents about a sixth of the total internal meatus. The number of these convexities varies according to the shape assumed by the gland. Young has tabulated

the various possibilities, and his diagram is reproduced in *Fig* 163 His figures require no text He says that "they cover (diagrammatically of course) the great majority of cases of prostatic hypertrophy There are certain irregular and bizarre types which are not included but which can be interpreted by a comparison with the foregoing

The commonest seats of change are the middle and lateral lobes The meatus is then shaped as seen in *Fig* 163 *a* (*see also Fig* 162) The median lobe presents a sharper curve than that of the two lateral lobes whose convexity is often slightly flattened by mutual pressure Above, the two lateral masses meet at an angle, and their upper extremities together with the intervening recess are easily seen in a single cystoscopic field The junction of the lateral lobes with the median is less acute than that formed anteriorly A fold of redundant mucosa is often to be observed in the bottom of these sulci

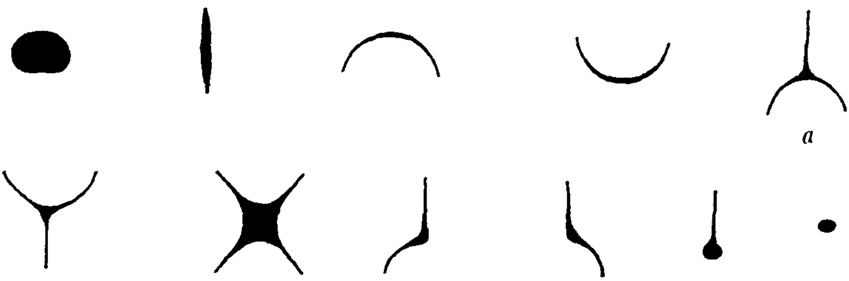


Fig 163 —The first figure represents the outline of the normal meatus the remainder show the possible changes which the orifice may undergo in prostatic hypertrophy (*Redrawn from Young*)

Occasionally it is œdematous and may, by close magnification suggest an additional lobe (*Plate XII* B page 272) Sometimes indeed sequestered adenomata do rest on the surface of the main tumour and form additional irregularities Anterior and circular enlargements are rare, but on occasion are of large development.

The *margin*, instead of being sharp, as in the normal state is rounded and less well defined It rolls away from the window of the instrument (*Fig* 168), and is therefore in less close apposition Its colour is deeper than that of the bladder except when the latter is reddened with cystitis. Owing to its shape it receives the light from the lamp directly on its surface in contrast with the normal neck which is transilluminated.

It must be recalled that the window of the cystoscope is so placed that deformities of the bladder neck are appreciated only when they occur in the sagittal plane of the body that is, parallel with the urethra (*Fig.* 164) Those occurring transversely require a urethroscope or a retrograde cystoscope for their recognition (*Figs.* 165 and 166)

Much might be expected in this disease from retrograde cystoscopy, and it was employed in 1900 by Young, but he soon abandoned it, finding that the instrument was optically less efficient, and that

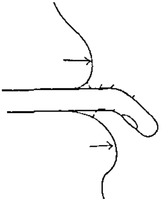


Fig 164.—Cystoscope examining prostatic hypertrophy appreciates increase of the gland occurring in the sagittal body plane

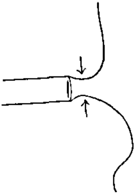


Fig 165.—Urethroscope examining prostatic hypertrophy appreciates increase of the gland occurring in the transverse body plane (cf Fig 166)

the interpretation of the images was difficult. Marion and Heitz Boyer also indicate that it is less generally useful than the ordinary cystoscope. Recently it has come into favour amongst surgeons practising endo-urethral prostatic resection. They aim at getting a clearer idea of the bladder aspect of the enlarged lobes before operation.

Inspection of the Retroprostatic Pouch.—The production of a valle cula surrounding the prostatic pro minence has been described. Its development varies in different individuals and at different stages in the growth of the adenoma. Usually deepest behind it produces a pouch at this point whose depths cannot always be displayed. The larger the gland the deeper will the pouch become. The thicker the median lobe the further will the window be held away from the edge of the declivity and the more diffi cult will it be to explore the recess.

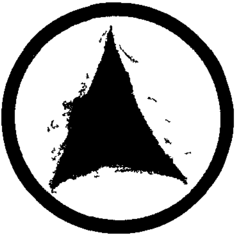


Fig 166.—Internal meatus in prostatic hypertrophy seen through the posterior urethroscope (cf Fig 165)

It has been shown that an acute bend in the prostatic urethra increases the depth of the fossa as seen cystoscopically (page 271). On these three factors will depend the extent to which the bladder base is concealed. In the least pronounced it can be exposed in its entirety

Where the gland is very large the whole of the trigone may disappear from view together with the ureters (*Fig* 169) Suggestions for uncovering it to some degree have been made on page 274 Stones and growths and the mouths of diverticula etc, may be overlooked when sheltered in this retreat.

In the normal individual it is never possible to bring the edge of the meatus and the ureter into the same field (*Fig* 167), but in prostatic hypertrophy the margin of the middle lobe and the ureter can be seen simultaneously save when the gland actually hides the latter (*Figs* 168 169) This observation (Marion's sign) is of much importance It is true not only of late but also of early cases By it early enlargement in which it may be difficult to satisfy oneself about the hypertrophy solely by reference to the configuration of the meatus may invariably be identified It should be noted however, that it is not entirely confined to adenoma of the prostate for other elevations of the bladder neck, such as occur for instance, in prostatitis and prostatic carcinoma, act similarly, though generally in minor degree whilst lowering of the bladder base as by cystocele in the female, can produce a corresponding phenomenon (*see* page 304)

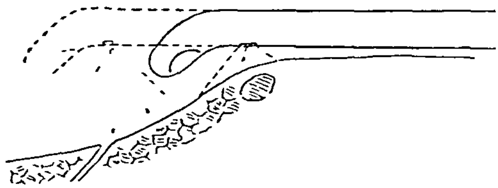


Fig 167—Showing that in the normal condition it is not possible to see the prostatic margin and ureter in the same field

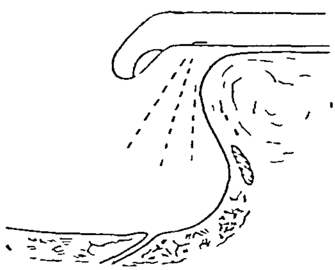


Fig 168—Showing that in prostatic hypertrophy it may be possible to see the prostatic margin and ureter in the same field (*Marion's sign*)

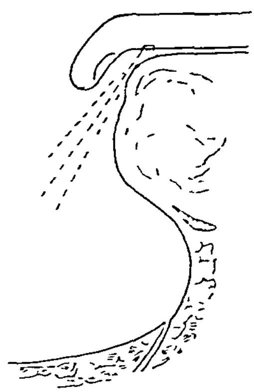


Fig 169—Showing that the ureter may be hidden by a very large gland Observe the position of the sphincter

It rarely happens that we need to catheterize the ureter in prostatic hypertrophy, but when the occasion does arise it may be found difficult or impossible The beak of the cystoscope cannot be approximated to the orifice, and a greater length of catheter has to be passed into the bladder

Renal function tests in this disease are usually carried out by the estimation of the blood urea and by the urea concentration test It is however possible to observe the efflux of indigo carmine at the ureteric orifices when these are not concealed and even when hidden the flow of dye into the bladder medium can be seen and its time and volume noted

Evidence of dilatation is sometimes observable at the ureteric orifice when back pressure has been marked (*see also* page 365) In the presence of cystitis the dilatation of the orifice may be masked by the œdema of its lips

The *size* of the prostate is difficult to estimate cystoscopically Some indication may however be gained by the extent to which the trigone is hidden and also by the difficulty experienced in approaching the fundus The fenestra is so close to the edge of the enlarged gland that the extent of the portion lying beyond which is foreshortened is not appreciated

The following method of estimating the relative sizes of the lobes is suggested by Cuthbert Wallace —

If the cystoscope is introduced with the window forwards and the point noted at which the edge of the internal meatus is first seen the distance of the anterior margin of the internal meatus from the exterior can be measured on the stem of the instrument If this process is repeated gradually turning the cystoscope round on its long axis a very good picture can be obtained of the inequalities of the projecting prostate Thus if the urethral margin is first noted on the posterior side when the cystoscope is introduced eight inches whilst on the opposite side it is noted at seven inches this shows that the prostate on the former side is projecting one inch further into the bladder than on the latter

A fair idea is usually attained by rectal examination especially if this is undertaken whilst the cystoscope is still in position so that the amount of tissue intervening between the shaft and the finger may be computed

THE VESICAL COMPLICATIONS OF PROSTATIC HYPERTROPHY

Some degree of alteration in the bladder in addition to that which has already been described is invariable The earliest changes are dilatation and hypertrophy

Dilatation —The increased vesical capacity has already been referred to Cystoscopically it is not evident unless a large quantity of bladder lotion is employed when the walls of the viscus will appear more extensive and more remote and wider excursions of the instrument will be required in order to display them

Hypertrophy —This is an invariable attendant It is evidenced by trabeculation The musculature of the inner coat becomes over developed The change is slight in the earlier stages but becomes more marked

as the obstruction increases Eventually the vesical wall presents a reticulum of countless muscular bundles, intertwining inextricably, and recalling to mind the columnæ carneæ cordis (trabeculæ carneæ).

Diverticula.—Both false and true diverticula (Plate VI A and B, page 152) are found in prostatic enlargement The false variety (*Fig* 84, page 151) is a counterpart of trabeculation and hypertrophy, small triangular or rhomboidal crypts separating the fleshy bundles and showing the effects of increased intravesical pressure The rounded orifices of true diverticula are seen less frequently, but their incidence is greater amongst prostatics than in the general population, which suggests that they owe their evolution in part, at least, to obstruction (*see also* page 159)

Cystitis.—A certain degree of hyperæmia is present even in the uninfected bladder, and results from the irritation of retention Thickened and tortuous vessels may be traced as they run amongst and across the trabeculæ, whilst the mucosa is pinker and somewhat granular Many cases, when first seen, are infected Every variety of cystitis is found from a mild blush to the most fœtid of ammoniacal infections with thickened and velvety mucosa, coarse purulent membranes, and perhaps stone formation The cystitis may be a 'spontaneous' (hæmatogenous) infection, the colon bacillus being responsible for many of these; but it is more often a sequel to instrumentation

Stone.—Stone formation is common and is usually of the secondary type The calculus occupies the pouch, and may be concealed behind the gland Retention and sepsis are responsible The stone may be single, but occasionally calculi are to be seen in great numbers as in *Plate XI* E, page 222, which also shows how the gland hides objects Occasionally a stone forms in a diverticulum (page 161)

When a calculus is discovered radiographically in an elderly man and lithotrity is proposed, a cystoscopic examination should precede the operation in order to exclude prostatic hypertrophy, the suprapubic route being preferable in the presence, to any important degree, of the latter

Growths of the Bladder.—It is not surprising that growths of the bladder are commonly associated with an adenoma of the prostate as so large a number of men past mid-life show some degree of the latter condition Many of them have no symptoms referable to their hypertrophy and in a majority of these interference is best limited to the bladder growth

MISCELLANEOUS DISEASES OF THE PROSTATE

Chronic Prostatitis.—Cystoscopy is not much used in this disease In the presence of a urethritis it is actually contra-indicated. The

pathological changes affect the posterior portion of the neck, which becomes hyperæmic and may be œdematous It is slightly elevated in all cases (Young) and may simulate early hypertrophy The overlying mucosa may be granular in appearance Obstruction to urination is uncommon

Tuberculous Prostatitis —This disease should be diagnosed by rectal palpation and by recognizing concomitant disease in other parts of the genito urinary tract With coexisting renal tuberculosis minor infections of *the prostate are probably present more often than we* recognize and cystoscopy directed to the investigation of the kidney does not appear to do any harm In advanced prostatic tuberculosis cystoscopy should be as far as possible avoided as it sometimes lights up the disease In the early stages the appearances resemble those seen in chronic prostatitis Later tuberculous lesions of the bladder *may be found if that organ* is also implicated Rupture of tuberculous abscesses into the bladder from the prostate and vesicles with the formation of crateriform sinuses has been described (*see also* Chapters VII and XV)

Fig 170 —Prostatic calculi of unusual development Stones buried in the substance of the gland

Stones —Stones in the gland itself are also common (*Fig* 170) They are usually small and multiple The situation and shape of the diffuse X ray shadow makes recognition easy

Cancer of the Pro tate —Prostatic *carcinoma is another disease* in which cystoscopy should be *avoided as a general rule though* occasionally it is justifiable where rectal palpation has proved inconclusive The latter will however generally be suggestive by the time that the disease is sufficiently advanced to present pathognomonic evidence in the bladder

The first observable changes are located in the anterior portion of the trigone behind the sphincter and consist of irregular puckerings of the mucosa occasionally associated with a certain degree of œdema They are probably attributable to contraction at the site of the growth and may be compared with the puckering of the skin seen over a mammary scirrhus This change is atrophic rather than hypertrophic and in fact elevation of the vesical neck is rare at this

stage, though it may occur in minor degree Later the growth invades the bladder, and irregular nodules of neoplasm may be observed. Evidence of obstruction may be noted in residual urine, dilatation, and trabeculation Harsh resistance to the cystoscope when traversing the deep urethra, and hæmorrhage on instrumentation are characteristic signs

In many cases the carcinoma arises deep in an area of prostatic hypertrophy The only cystoscopic signs are then those associated with simple enlargement, so that whilst positive evidence of prostatic carcinoma is valuable, the cystoscopic appearances which characterize simple prostatic hypertrophy do not necessarily exclude prostatic carcinoma

ENDOSCOPIC PROSTATIC SURGERY

"There is no new thing under the sun" Guthrie, over one hundred years ago, attempted the perurethral treatment of prostatism by means of a concealed knife, and in 1874, Bottini produced a galvano-cautery blade hidden in a catheter, which, when heated, destroyed the tissue of the bladder neck Modern endoscopic prostatic surgery is developing along two alternative but independent lines, the one employing the cutting current, the other the punch These two methods have much in common in that many of the problems involved are identical

INSTRUMENTS USING THE HIGH-FREQUENCY CUTTING CURRENT

On its discovery the high-frequency cutting current was early applied to the treatment of bladder-neck diseases, although there was at first some difficulty in making the current effective under water The most popular instrument at the present time for use with this current is that designed by McCarthy in 1931, with which slices of tissue can be removed by a wire loop electrode, under vision

The McCarthy Electrotome (*Fig* 171) —This consists of a sheath, an obturator, lighting arrangements, a foroblique telescope, an activated and mobile loop for electric cutting, and irrigating parts

The Sheath —This consists of a tube made of bakelite or other insulating material, $8\frac{1}{2}$ in long, and its size corresponds to 28 on the French catheter scale It is cut away at the bladder end in order that the loop may have access to the prostatic lobes At the external end is a short tubular metal attachment with a coned chamber (A) to receive the loop carrier, a revolving collar (B) carrying the three-way irrigating cock (C) is mounted on this chamber, which covers an annular groove through which the fluid flows into the sheath in whatever position the tap may be The horizontal branch of the tap is connected to an irrigator, the vertical branch is provided with a length of rubber tubing with a sinker at the end resting in the waste bucket

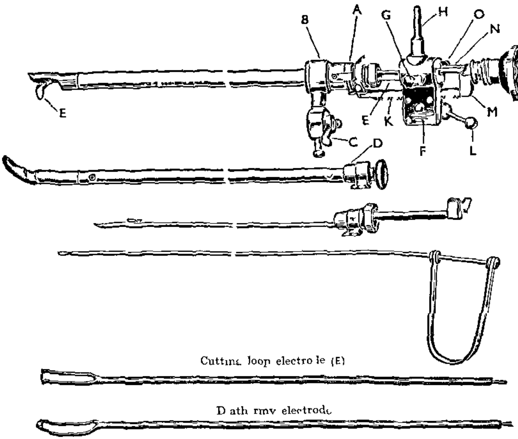


Fig 171 —McCarthy's prostatic electrotome

The Obturator —At the outer end of the obturator is a cone (D) shaped to fit the coned chamber of the sheath The sheath and obturator are locked together by the spring clip on the sheath The beak of the obturator is hinged to a spring loaded draw bar housed inside the hollow shaft of the obturator The spring holds it in the raised position but yields enough to force it into alinement during its passage through the sheath

The Foroblique Telescope—This resembles a direct vision telescope In front of the objective is placed a deviating prism The

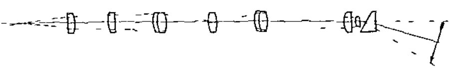


Fig 172 —The lens system (simplified) of the Foroblique telescope

system (*Fig* 172) consists of eighteen lenses and one prism As the prism is a deflecting prism an odd number of inversions is required

to obtain an erect image This is different from the cystoscope, where an even number of inversions is needed behind the right-angled prism (*see* page 19) The telescope is housed in the loop-carrier into which it is secured by friction.

The Loop-carrier —The cone on the loop-carrier fits into the cone chamber on the sheath (A) and is fixed thereto in the same manner as the obturator Through this cone pass :—

1. The telescope carrying with it the parts concerned in lighting The whole is removable as a unit

2 The loop-electrode (E), likewise a removable unit It consists of a long insulated shaft which passes through a guide tube and the cone to reach the electrode carrier (F) into which its flute-shaped end engages It is fixed by the screw (G). On loosening the screw the electrode is easily withdrawn and replaced by another, or by the coagulating electrode. At the vesical end the electrode shaft divides into two arms which carry the loop or ball electrode

The loop-carrier proper (F) is a cylindrical block of bakelite provided with a connecting pin (H) to which the cable from the diathermy machine is attached It is a mobile unit sliding on a rack (K) fixed to the cone and is moved to and fro by a pinion and handle (L) The total excursion of the loop is 1 in A rectangular projection (M) and the end of the rack support the proximal end of the telescope A keyway cut in this projection engages the guide pin (N) and automatically keeps the telescope in the correct position The small spring-loaded bolt (O) on the loop carrier engages the guide pin when during the cutting of the prostate, the loop has moved about half an inch on its way back into the sheath and pushes the telescope towards the observer After each cut the telescope must be advanced again into its original position the bolt being pressed aside to let it pass The reasons for moving the telescope are firstly to allow the maximum amount of tissue to sink into the gutter and secondly to prevent damage to the telescope through occasional sparks from the loops

Selection of Cases.—Great difference of opinion prevails on the subject of the selection of cases for some surgeons perform perurethral resection every time whilst others adhere faithfully to the older operation Yet greatly though men s choices differ each procedure appears to have a place and all urological surgeons should attempt to master the suprapubic technique and one or both of the perurethral operations The writer chooses the perurethral route in about 15 per cent of his patients and though preferring the open operation for routine work, he would not willingly forgo the advantages of resection in selected cases For a straightforward prostate he feels happier with the open technique because the results are more assured

It is generally conceded that large prostates, especially the large intravesical type should be dealt with by the open method because of the increased difficulties—the greater mass to be removed, and the greater vascularity which is so often observed in large adenomata But, as shown on page 279 considerable difficulty attends the accurate determination of size for its cystoscopic recognition is notoriously fallacious It is by no means a unique experience for a competent cystoscopist to open a bladder which he has carefully investigated only to find that his impression of the size of the prostate was completely wrong and though the estimation of the length of the urethra by urethroscopy is more dependable it cannot be relied upon implicitly Again the rectal examination is likewise deceptive a trifling enlargement as felt per rectum being often associated with a large intravesical prominence The identification therefore of suitably sized prostates presents real difficulties

Conversely the small prostate should be suitable for perurethral resection and with some operators it is becoming standard practice to do a prophylactic resection on the first appearance of prostatic symptoms

Fibrous contractions of the vesical neck and median bars give admirable results in a large proportion of cases The operation is easier than it is in adenomatous disease less tissue needs to be excised and bleeding is less troublesome Either the cutting current or the punch should be preferred in this group

The introduction of stilbœstrol in the treatment of prostatic cancer has limited the usefulness of resection in that disease but resection continues to be valuable where retention persists The malignant tissue cuts well there is a striking absence of hæmorrhage a complete even if temporary relief of obstruction is obtained and a suprapubic fistula is thus avoided To set against these advantages is a fair body of evidence to prove that the disease is disseminated by the treatment that distant metastases occur earlier and presumably life is somewhat shorter than it might have been had a cystostomy been done The writer holds the view that the advantages of resection for carcinoma of the prostate outweigh its disadvantages, but that its use should be strictly limited to cases where there is real obstruction to micturition and that the patient should be encouraged to carry on so long as he is reasonably comfortable and there is but little residual urine

Sepsis of any severity is a definite contra indication to the perurethral operation which is very liable to add fuel to the fire (*see also* page 294)

Renal insufficiency is no reason for preferring resection From the point of view of the kidney the two procedures are equally trying

Function must be improved by identical means and must stand equally high whichever route is selected.

What about the rather feeble patient on whom one hesitates to do an operation? Is he suitable for resection? The matter rests on the knees of the gods If success attends at all it probably attends in generous measure If, on the other hand, one meets with hæmorrhage, clot retention, or sepsis the strain on the patient's vitality is just as great as that of the major operation It is a gambler's throw, with the odds perhaps on the resection. One factor however is definitely favourable to the perurethral route when dealing with enfeebled subjects—a low spinal anæsthetic one affecting only the sacral nerves, is adequate and is better borne than the higher level anæsthesias required for the open operation But the patient must not be led to think that the operation is a minor one and devoid of risk

Two cases may be cited to illustrate a type of work in which the electrotome plays a valuable role.

Case 1.—A man at the age of 69 developed torsion of an inguinal testis and the testis was removed Retention of urine occurred as a post-operative complication and, as it persisted, was rectified by prostatic resection Convalescence from this second operation was a matter of but a few days

Case 2.—A patient aged 65, was referred to me from the hospital of a distant town He had an advanced mediastinal growth and for some weeks had also been confined to bed with an inlying catheter. The removal of a few strips from his prostatic urethra restored the function of micturition, and the operation, performed under low spinal anæsthesia was without ill-effect on his general condition.

Pre-operative Treatment.—The pre-operative examination of patients who are to undergo endoscopic resection of the prostate differs but little from that employed when the open operation is contemplated The cardiovascular and respiratory systems are carefully examined the optic discs and blood-pressure not being overlooked Renal function tests are routinely performed, and when there is residual urine a period of decompression must be considered. The condition which is under treatment is not so much the prostate as the obstruction and its effects It is well known that the mortality following the first stage of a two-stage suprapubic operation is higher than that of the second. The first stages and the accompanying mortality are identical for the perurethral and for the open operation This feature appears to be remediable only by earlier application for treatment

Bladder drainage is usually by an inlying catheter, but for the more severe or protracted cases a suprapubic fistula is good practice The presence of a fistula modifies the subsequent operation very little. McCarthy recommends that "one should introduce suprapubically

a fairly large Pezzer catheter which prior to operation is gently but firmly lifted pulling the bladder wall with it A Kelly clamp is then applied to the taut catheter close to the abdominal wall This step effectively seals the bladder opening Otherwise the operative steps are the same

Though the foroblique telescope is an excellent instrument for the study of the bladder neck it is but a poor implement for investigational work within the bladder Partly for this reason and partly because time is saved at the actual operation a pre operative study of the bladder neck by cystoscopy and urethroscopy is made with a view to determining the configuration of the prostatic lobes and the length of the supramontanal urethra It may also reveal various complications—stone diverticula etc —in the bladder which might decide the surgeon in favour of the open operation

Technique—For endoscopic resection of the prostate a quite low spinal anæsthesia is all that is necessary One of the heavy solutions of novocain is given with the patient sitting up to encourage the anæsthetic to sink to the lower end of the spinal theca Though only the sacral nerves are affected the anæsthesia is excellent and there is a minimum of shock or physical disturbance

The patient occupies the usual cystoscopic position and his sacrum rests on a large indifferent electrode The surgeon takes up his position between the thighs Some men prefer to stand others to sit The former escape the considerable spilling of bladder lotion which is almost inevitable in this procedure but the standing position is uncomfortable and awkward and would appear to be impossible to men above medium height In comparison with cystoscopy this operation calls for much mobility on the part of the surgeon especially when the loop is being placed and this is a fact favouring the standing position always provided that the table can be raised suitably The sitting position makes it necessary to protect oneself with waterproof leggings of which one of the types made for the motor cyclist may be recommended Rubber gloves are worn for their aseptic value They were previously stated to offer protection against high frequency discharges when the current is running but these minute discharges can be prevented by earthing the plate (indifferent electrode) *

The sheath is loaded with its obturator by engaging the beak in the proximal opening and depressing the shaft until it is in alinement with the sheath When the key engages in the notch on the conical chamber the beak will be automatically drawn up into the

* Personal communication from Mr Schranz who has given considerable help in the preparation of this section

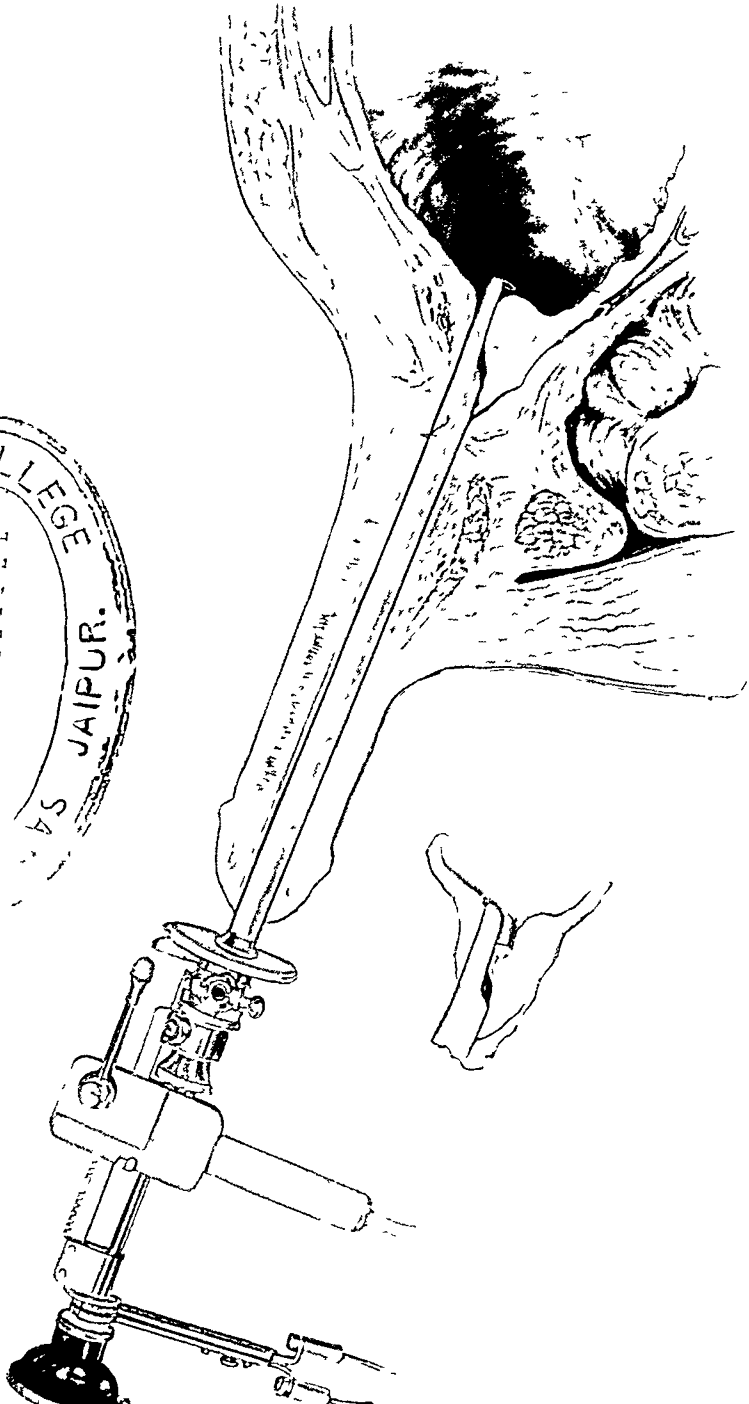


Fig 173 —Resectoscope (earlier model) in position ready to remove a slice from middle lobe *Inset* —Cutting in progress

The slices that have fallen into the bladder will be washed out by the rush of fluid which follows the withdrawal of the carrier This fluid should be caught in a specimen glass by an assistant and the piece of tissue is thus recovered and kept Slices that fail to come out must be recovered with the forceps specially designed for the purpose When all the pieces have been recovered the carrier is replaced in the sheath and the telescope which has moved back during the cutting process is pushed forward again into the initial position The anterior limit of the cut is indicated by the verumontanum this important landmark must always be intact at the end of the operation Cutting beyond it may damage the compressor urethræ and result in permanent incontinence This landmark appears in the lower part of the visual field and before any cutting is attempted the resectoscope must be so disposed that it is out of view

Experience will soon tell the best speed to move the loop Too slow a speed causes unnecessary charring one which is too quick leaves the vessels unsealed and leads to subsequent difficulty from hæmorrhage Between ten and fifteen seconds should be taken to complete the cut Sometime when such is available it makes an instructive experiment to test the ease of cutting and the current required on a prostate which has been acquired suprapubically

The length of a slice is variable anything up to the total distance through which the loop moves namely one inch The first slice is covered on its urethral aspect with mucosa and its cut surface which is shaped to the form of the loop is grey in colour from the charring and is transversely ridged from the uneven progress of the electric knife A second slice cut from any position where a previous cut has been made is charred on each surface and from the double contact with the wire is concavo convex in transverse section Between the two charred surfaces of such a specimen there is uninjured tissue which has not felt the effects of the heat and is thus suitable for microscopical examination

The line of the cut is usually clearly visible as a shallow trough of greyish colour and is transversely ribbed by the action of the cutting wire At one or more places may be seen cone shaped jets of blood springing from a small point The bleeding often appears to be quite furious and pulsation may sometimes be observed but is more usually absent The surgeon may decide to seal these spots immediately with the diathermy electrode but as a rule leaves them for a time whilst further strips are removed

The position of the cuts is regulated by that of the main enlargement and the number taken away by the size of the prostate i e, by the depth of tissue which the surgeon judges he has to work upon Usually the middle lobe is the first to be attacked and when a

sufficiency of this has come away the operator turns his attention to the lateral prominences As soon as he thinks he is reaching the danger zone he will stop One of the anxieties of this operation arises from the impossibility of knowing just how much tissue is left between the new channel and the prostatic sheath. An attempt may be made to compute the size of the prostate beforehand, although this is but an approximation (*see* pages 279 and 285), and one still can only guess when the limit is being approached. The principal attack is on the inferior section of the meatal circle. One rarely cuts above the equatorial line and indeed the prostate becomes so thin anteriorly that the possibility of perforation into the space of Retzius makes this an area to be avoided Generally, then, the operation is limited to the lowest third of the circle A good gutter in this situation will be found to do all that is required, and it is here that the greatest thickness of tissue exists, and therefore the biggest safety margin The whole slice comes from the supramontanal region That structure must on no account be damaged.

McCarthy recommends that the middle lobe should be first approached, because if anything happens to interfere with the subsequent progress of the resection " it may at this point be terminated with resultant symptomatic relief ". He also points out that sometimes when the middle lobe has been removed the lateral lobes move inwards towards the centre of the endoscopic picture and their demand for treatment is accentuated.

The sections removed are laid out on a piece of lint in the bottom of a kidney bowl Having removed a certain number, the surgeon looks at them with a view to deciding their aggregate size A good way is to gather them side by side between the fingers Estimate thus the bore of the new channel and, allowing for inward pressure from remaining parts, consider whether an adequate passage has been provided.

At the end of the operation the bladder is irrigated to empty it of blood and clot The diathermy electrode (*Fig.* 171, page 283) is meanwhile being fitted to the carrier, and any bleeding points which can be seen are now touched under vision Time spent in sealing the bleeding points will be amply rewarded by relative freedom from post-operative hæmorrhage. The surgeon must be prepared if necessary to spend as much time in controlling hæmorrhage as on the operation itself. Complete hæmostasis and a clear wash is the ideal but is not always achieved. The correct current for this purpose must be learned. Too strong a current will puncture a vessel and prolong hæmorrhage even making it come from a deeper and more inaccessible plane Again, too severe and too deep coagulation is dangerous in that it may produce a large slough which takes time to

separate and meanwhile causes much sepsis It may even lead to late extravasation of urine or secondary hæmorrhage A properly regulated coagulating current produces a slow blanching of the bleeding point with an almost entire absence of spluttering

Finally a catheter of large size (24 French) with a whistle shaped terminal opening is placed in the urethra and is fixed in position with strapping applied round the penis The catheter is given a wash with lotion to make certain that it lies properly and that its lumen is clear

After treatment—Frequent irrigation through the catheter helps to ensure that the lumen is kept free from clots or at least gives prompt warning of catheter blockage which is more easily overcome at this stage and does less harm if caught early The catheter is retained for three days but in cases where only a small amount of tissue has been removed, as for instance in the excision of a median bar it may be dispensed with after twenty four hours Urination is usually immediately successful though there may be some hesitation at first A poor stream and even some residual urine may sometimes result from œdema of the vesical neck but when this is the cause it quite soon rectifies itself though the full benefit of the operation may be delayed occasionally for a few months

If in the pre operative treatment a cystostomy opening has been made it should be retained in the post operative period until the catheter has been removed Then by clamping the cystostomy tube it becomes possible to prove that the bladder function will be satisfactorily restored Should there be any doubt about this the tube may be kept for a further length of time or if necessary until a repeat session is judged to be called for

Repeat sessions are not very common They may be required if the excised mass has been insufficient Sometimes this is due to the operation having been cut short by technical difficulties such as hæmorrhage Everidge considers that at least a month should elapse before the second operation is embarked upon thus giving time for the urethral convalescence to become well advanced Alcock is moving in the direction of designedly doing the operation in two sittings and claims that the second resection is always easier to do than the first and that tissue can be removed in larger quantities and more rapidly

Complications—The principal complications are hæmorrhage sepsis epididymitis extravasation of urine uræmia and stricture

Hæmorrhage—Primary hæmorrhage is virtually a continuation of the bleeding at operation which has refused to be satisfactorily controlled In addition to the resulting shock it plays an important part through clot retention Loughnane as a preventive of clot retention recommends the continuous irrigation of the bladder through

a two-way catheter with a 3 per cent solution of sodium citrate, starting from the time of leaving the theatre This I believe is very effectual, but in criticism it may be argued that it defeats nature's own method of hæmostasis Clot retention may be rectified by lavage by a change of catheter, or may require the use of a Bigelow's evacuator A better method than using the rubber aspirator is to pass the large, thin-walled catheter belonging to that instrument and to apply suction by an ordinary bladder syringe The suction thus obtained is under better control and is more steady and gentle than that obtained with the evacuator It is a valuable means of overcoming clot retention in this as also in hæmorrhage from other causes Once emptied of clots, the bladder is irrigated with hot lotion (115° F) and an inlying catheter is again inserted or a Foley catheter

Should hæmorrhage and clotting prove obdurate, the bladder must be opened and the clots evacuated Hæmorrhage may then be controlled by a Pilcher bag or by packing with gauze On two occasions in the writer's experience a suprapubic opening, originally employed for the treatment of deficient renal function, has proved serviceable for the escape of clots and the treatment of bleeding Some writers have indeed spoken favourably of suprapubic drainage prior to endoscopic resection as a routine measure

Secondary hæmorrhage occurs in about 3 per cent of cases and may prove a very serious complication If the usual urethral evacuation is not quickly successful the bladder must be promptly opened

Clot retention is an important cause of death In Doyle and Feggetter's statistics it accounted for one-third of the deaths recorded, and excessive hæmorrhage was noticed by them in 21 cases out of a series of 156 resections

Sepsis—This is present in greater or less degree in all cases and in some it assumes great importance It is well known to be virtually impossible to avoid some measure of sepsis when bladder drainage is instituted The pre-operative period is therefore responsible for some degree of infection and after the operation this thrives on the charred areas left by the burn In the presence of severe sepsis resection is inadvisable Some sepsis being inevitable it must be treated from the beginning by local and general antiseptics Occasionally a fulminating or gangrenous cystitis is observed Extension of infection to the kidney is not uncommon

Epididymitis—Many surgeons appear to have suffered severely from this complication, one observing it in nearly 50 per cent of his cases The present writer has been almost free from this trouble and thinks that this may be due to care in avoiding injury to the verumontanum In those patients who do develop epididymitis it usually makes its appearance shortly after the catheter has been

removed, but it may delay its onset till some time following the patient's discharge from the hospital. If a series of cases were giving trouble with epididymitis it would be rational to counter it by section of the vas before or at the time of operation, a procedure which has become routine practice in suprapubic prostatectomy.

Extravasation of Urine.—Extravasation following prostatic resection is a very fatal accident. It may take place immediately after the operation, when it is without doubt due to perforation of the bladder by the electric knife. Not a few cases are due to a direct cut through the bladder base, the landmarks having been mistaken. Some of these have involved the rectum. The importance of avoiding the anterior commissure has already been pointed out (page 292). Less commonly extravasation makes its appearance some time after the operation and is then probably due to sloughing of coagulated tissue. As soon as urinary extravasation is discovered, open operation offers the only hope of successful treatment.

Uræmia.—This is met with in a few cases. It may occur early as a reflex arising from instrumentation, or later, when ascending renal infection is the probable cause.

Stricture.—This is a late complication and may affect the vesical end of the tube, the actual site of the cutting. Too deep hæmostatic coagulation is thought by Doyle and Feggetter to be possibly responsible. Alternatively, stricture formation may involve the anterior urethra, when the trauma caused by the large size of the sheath must be held accountable. The incised external meatus sometimes becomes strictured.

Results.—When the results are good they may be brilliant. The convalescence is short and function is completely restored. In the best cases there is practically no shock and little or no post-operative disturbance. To regard endoscopic resection, however, as a *minor* operation, and especially to give patients that idea, is unjustifiable, for the procedure carries with it a very definite mortality. Many of the excessive claims advanced by enthusiasts stand self-condemned and will be immediately discounted by such as have had some practical experience. The type of risk from which prostatics are drawn, many of them old, worn-out men with no resistance and perhaps suffering from independent disease, would show a mortality from the most trivial surgical interference. Such a statement would not be necessary had not too much been claimed for the operation, and it is made without the least intention of disparaging what is undoubtedly a valuable addition to our resources.

Perhaps the most reliable and balanced paper dealing with results is that by Doyle and Feggetter. It is compiled from a study of the work at the All Saints Hospital, London, where this form of

treatment for prostatic hypertrophy is much favoured These writers found that out of 123 operations, 62 patients might be regarded as good results, showing improvement of the general health, an absence of difficulty of micturition, scalding, frequency or pyuria Cystoscopically these patients had no cystitis and urethroscopically a good shelving floor In a second group 19 patients were placed "who have been greatly improved by the operation, but in whom all the above requirements have not been fulfilled". In 9 further cases the symptoms were not alleviated. Fifteen died after operation 6 died within three years, and 12 were untraced In 156 cases there were 18 deaths (11 per cent) Clot retention was responsible for 6, uræmia for 3 pyelonephritis for 2, extraperitoneal rupture of the bladder for 2, and the remainder were due to pneumonia embolism, etc

One fact appears in all published figures—that the results of the operator improve materially as he gains experience The instrument is an exceptionally dangerous one in unpractised hands and the *operation—one of the most difficult in cystoscopic surgery—is essentially* one for the specialist Even those who are experienced in ordinary cystoscopy and urethroscopy would be well advised when entering this field, to select for their early ventures the simplest kind of enlargement, and indeed in this country most surgeons tend to limit themselves more and more to this variety.

PUNCH PROSTATECTOMY

By R H O. B. Robinson

Punch *prostatectomy, though not a new idea* was placed on a sound practical basis by the pioneer work of Bumpus at the Mayo Clinic and was developed and extended by Thompson and his co-workers The basic principle on which the method is founded is the cutting of obstructing prostatic tissue with a circular knife thereby enabling the operator to remove larger amounts of tissue in a given time and reducing to a minimum the amount of necrotic material left behind The only coagulation carried out is that necessary to control individual bleeding points Bumpus originally harpooned the tissue to be punched away with multiple needles and coagulated the mass with a diathermy current He rapidly abandoned this step as unnecessary, undesirable, and time-consuming Cuts are made upwards away from the verumontanum as a fixed point In this way the risk of *damage to the external sphincter,* with resultant incontinence, is reduced to a minimum Punches are relatively large instruments 30 F, although a 27 F, Thompson punch is manufactured In all cases where the urethra is small a perineal section should be made and the instrument introduced into the bladder through the urethrotomy

wound This minimizes the risk of a post prostatectomy stricture in the anterior urethra

Punches are developed from the Braasch direct vision cystoscope a lensless instrument and it is therefore desirable to acquire experience in the interpretation of urethral findings with this before embarking on the use of the punch The Bumpus instrument (*Fig* 174) is simple to master and is suitable for cases where the resection of a small amount of tissue is sufficient It consists essentially of a direct vision cystoscope size 30 F with a fenestra cut out of the ventral surface of the sheath close to the beak Any obstructing tissue at the bladder neck must become engaged in this on attempting to withdraw the instrument and while thus engaged it is cut off by driving the

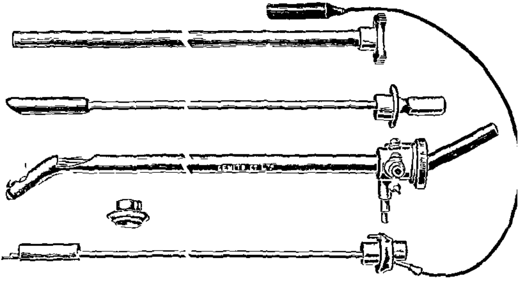


Fig 174 — The Braasch Bumpus prostatic punch

circular knife down the lumen of the sheath The detached piece is then forced out through the sheath by the pressure of fluid in the bladder Further cuts are made until a wide open bladder neck is obtained Bleeding points are coagulated with a diathermy electrode introduced through the sheath in a separate carrier Considerable time is wasted by the necessary withdrawal of the knife after each cut and by the introduction of the separate diathermy electrode when necessary

To obviate these deficiencies Thompson combined all the essentials in one instrument The knife in the forward position closes the fenestra converting the instrument into a direct vision cystoscope When it is drawn back to its full extent the fenestra is fully open and the knife can then be driven forwards to cut off the engaged tissue The process is repeated indefinitely until sufficient tissue has been removed or hæmorrhage requires control For the latter purpose

the electrode is projected from a separate channel in the upper part of the sheath, which is ovoid in shape, consisting of a large bore tunnel for the knife in the ventral part and a fine channel for the electrode in the dorsal

The operation is carried out as a rule under low spinal anæsthesia with the patient in the cystoscopy position. A plentiful supply of sterile water is essential and this should be at a height not greater than 4 ft above the bladder to avoid overdistension The parts are cleansed and sterile drapes are applied. The urethra is dilated if possible to 30 F., and the punch, well lubricated is introduced An inspection of the prostatic urethra and bladder neck is next carried out and punching is commenced When punching, the inflow of fluid into the bladder is stopped while the outflow is left open Thus detached pieces are washed out Assuming that a trilobar prostatic enlargement is being dealt with, the first cuts are made at two and ten on the clock face. This allows the lateral lobes to drop back and renders subsequent cuts easier In the case of middle-lobe enlargements or fibrotic bars at the bladder neck these are dealt with only but some operators prefer to remove the median part first when dealing with trilobar enlargements It is essential that the knife should be really sharp as otherwise the ribbons of tissue may not be detached completely, giving rise to unnecessary hæmorrhage A portion remaining attached by the upper end can be picked out by crocodile forceps introduced down the sheath of the instrument Punching should be continued until the pearly transverse fibres of the prostatic capsule are visible When dealing with the deeper parts of the lateral lobes it may be found helpful to have an assistant push them up into the urethra by a finger introduced into the rectum Bleeding spurters are coagulated if hæmorrhage is troublesome but undue time should not be spent over this during the operation as arterial hæmorrhage often stops on cutting away partially detached portions of gland The danger spots are in front where the gland is thin, and high up and far out where the ureteric orifices may be endangered

At the conclusion all major spurters are controlled by diathermy coagulation, and any clots or pieces of tissue remaining in the bladder are evacuated with a syringe attached to the sheath of the punch after removing the terminal window In this instance the punch functions as a bladder evacuator The wash-out should be pink in colour at the conclusion and no attempt should be made to render it completely colourless An indwelling catheter is then inserted either a whistle-tip secured with adhesive to the penis or better a self-retaining catheter of the Foley type which can then be used if necessary for hæmostasis It is wise to leave some 6 oz of fluid in the bladder and spigot the

catheter until the patient has been returned to the ward The catheter is then connected up with sterile tubing to a sterile container hanging from the side of the bed

After treatment consists of ensuring free drainage from the catheter by vigilant attention and repeated small bladder wash outs when necessary Strict aseptic precautions must be enforced when these are carried out Clot retention in the bladder is the only real major complication of the operation and should be avoided in the majority of cases by careful attention In the event of its occurrence the catheter must be changed an evacuator introduced the bladder cleared and a fresh catheter inserted It is unusual for the hæmorrhage to require any further steps as it will have ceased Forced fluids and sulphonamide therapy should be given throughout the treatment The catheter is removed from the second to the fourth day depending on the extent of the resection If there is difficulty in voiding or any gross residuum in the bladder after its removal further resection is usually indicated and it is one of the advantages of the method that this can be carried out with no greater difficulty than the original operation

Indications—The method can be used to treat all types of prostatic obstruction It is ideal where a small amount of tissue requires removal as in sclerosis of the bladder neck middle lobe enlargement and carcinoma In the hands of the expert resection of very large glands is possible in a reasonable time that is to say within one hour beyond which time no resection should be prolonged In true enlargements it is essential to remove a considerable amount to produce complete relief in other words to perform a prostatectomy and the proceeds of any resection should always be weighed wet in the fresh state at the conclusion of the operation It must be stressed that the operation is a prostatectomy and not a tunnelling The presence of retention of urine or raised blood urea level does not contraindicate the operation in any way When gross sepsis is present in the bladder pre operative treatment will be necessary to relieve this and in certain cases a preliminary cystostomy may be required

Complications—These are immediately hæmorrhage sepsis and renal failure and remotely urethral stricture and recurrent prostatic obstruction Primary hæmorrhage is dealt with on the lines already mentioned and varies in amount to a considerable extent A point to be borne in mind is that during resection a patient can lose a considerable quantity of blood which is washed away and is therefore apt to escape notice In certain cases therefore blood transfusion will be indicated The essential danger of hæmorrhage is post operative clot retention which produces profound shock and anuria Its prevention is better than its cure

outline, the median antero-posterior measurements being much diminished, whilst the lateral horns become more emphasized The segment of the bladder on which the ureteric orifices open is now bent back so as to lie approximately in the sagittal plane the orifices face directly outwards, and their identification may be a matter of some difficulty

2. Vascular Phenomena.—The bladder shares in the pelvic hyperæmia of pregnancy All types of vessels are dilated so that the mucosa shows pronounced vascularity The veins become dilated, tortuous, and even varicose They occasionally rupture, giving rise to profuse hæmaturia This hyperæmia, more marked in the trigone and base, is observable over the whole of the mucosa The plicated appearance of the vesical neck, which was noted as being normal in the female, is increased in pregnancy, the furrows and ridges becoming deeper and longer

Fig 176 —Stone in right ureter of a woman 8 months pregnant Repeated attacks of colic Two dilatations of ureter, the second with Bransford Lewis's dilator (*see Fig* 219) Stone passed four days later

The pregnant state does not greatly complicate cystoscopy until the last month arrives On nearing full term the uterus sinks into the pelvis and the investigation becomes much more difficult That it is not impossible is shown by the instrumental delivery of the stone seen in *Fig* 176 during the final month of pregnancy I was thus privileged to pluck this less agreeable fruit from the urinary tree before that other and more pleasing fruit also of the loins, was fully ripe for gathering After parturition cystoscopy again becomes easy It reveals, as a rule, the effects of trauma the bladder being more or less bruised and œdematous which may explain the vesical trouble so frequent after delivery

UTERINE DISPLACEMENTS

Anteflexion.—This is an exaggeration of the normal position of the uterus and has little effect on cystoscopy It increases the slight

boss formed by the fundus of the uterus and approximates the postero superior and anterior walls of the bladder The normal condition is shown in *Fig* 177

Retroversion and Retroflexion—In these conditions the uterus is bent over backwards so that the cervix indents the vesical wall

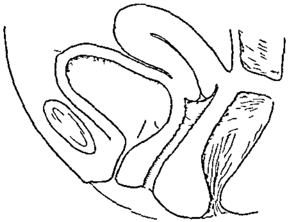


Fig 177—Normal relations of bladder and female adnexa

(*Fig* 178) It comes into relationship at the level of the interureteric bar and the bas fond Here a median elevation is produced so that in this position the bladder becomes convex from side to side and its lateral recesses are deepened The ureters now open on the declivity

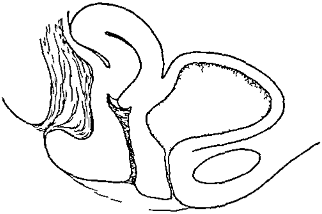


Fig 178—Effect on the bladder of retroflexion of the uterus

which leads into these recesses and instead of facing forwards they look to some extent outwards

Prolapse Cystocele—Uterine prolapse (*Figs* 179 180) may be slight or may be so extreme that the greater portion of the bladder comes to lie outside the vulva In either case but particularly in

and this may be due to an actual elongation of the urethra itself or may in part result from effacement of the lowest segment of the bladder by pressure from the fibromatous cervix Changes similar to this are also found when the gravid uterus is retroflexed When the myoma occupies the *isthmus*, distortion of the bladder occurs in the region of the trigone and ' bas fond '. It is similar to that noted in retroflexion. except that the fibromatous cervix is usually broader than the normal one Occurring in the *body* of the uterus fibromata cause deformity. which is very variable according to their size It may be so slight as to be only the merest exaggeration of the normal uterine imprint. or when severe it may cause compression of the

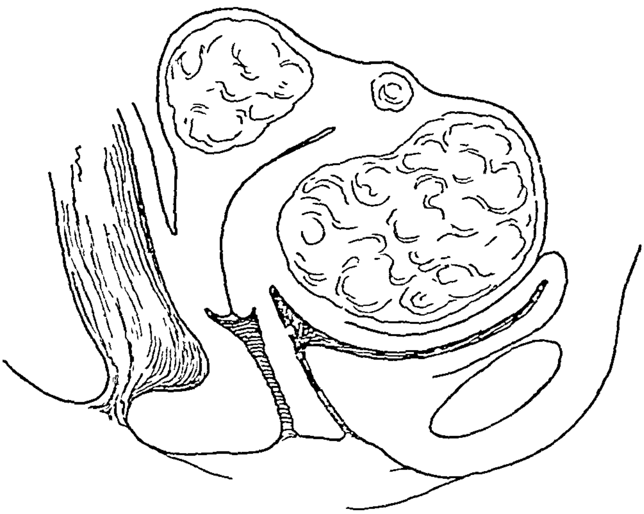


Fig 181 —Effect on the bladder of uterine fibroids

bladder against the pubes with complete obliteration of the vesical cavity (*Fig*. 181) In general the tendency is for a reduction to occur in the antero-posterior measurements of the organ

Urography.—Fibromyomata of the uterus are capable of causing ureteric and pelvic dilatation but it is rare for this dilatation to assume the proportions seen in pregnancy (*see* page 520) even when the myoma is impacted in the pelvis. This observation appears to support the view that the dilatation of pregnancy is in large measure of neuro-muscular origin Uretero-pyelectasis is more common in a variety of disorders of the female pelvis than is customarily realized The subject has been studied by Kretschmer and Kanter, whose table is appended (page 307)

Carcinoma of the Uterus and Cervix.—The investigation of a case of uterine cancer has till recent years rested almost entirely on vaginal and bimanual palpation but the importance of cystoscopy and pyelography is being more and more acknowledged by gynæcologists,

OBSERVATIONS ON PRE-OPERATIVE PYELO-URETEROGRAMS

	FIBROIDS ABOVE BRIM OF PELVIS	FIBROIDS BELOW BRIM OF PELVIS	OVARIAN CYSTS	PROLAPSES	TUBO-OVARIAN ABSCESS	TOTAL
Normal	7	5	2	3	1	18
Unilateral dilatation	6	3	4	0	0	13
Unilateral dilatation and unilateral displacement	0	1	0	0	0	1
Unilateral dilatation and bilateral displacement	2	0	1	0	0	3
Bilateral dilatation	3	1	3	1	0	8
Bilateral dilatation and unilateral displacement	3	0	1	0	0	4
Bilateral dilatation and bilateral displacement	1	1	0	0	0	2
Unilateral displacement	1	0	0	0	0	1
Bilateral displacement	1	0	0	0	0	1
Total	24	11	11	4	1	51
Normal	7	5	2	3	1	18
Pathologic	17	6	9	1	0	33

The majority of these dilatations disappear on removal of the cause

amongst whom both Gemmell and Todd have reported on the cystoscopic findings in long series of patients and Todd and Graves have separately studied their implication of the upper tract

The bladder lesion in this disease invariably overlies the cervix uteri and therefore shows itself centrally situated in the region of the interureteric bar The following vesical changes may be observed according to the age and the character of the neoplasm —

1 Mechanical distortion due to protrusion of the bladder wall by the neighbouring tumour and of type similar to that observed in uterine retroversion or enlargement of the uterus by fibroids This distortion is usually of slight degree

2 The earliest signs of invasion are increased vascularization (with or without varices) petechiae and diffuse or bullous œdema of the vesical mucosa at the spot which overlies the neoplasm Transverse ridging of the mucosa is a variety of œdema not often seen apart from carcinoma of the cervix It affects the trigone and retrotrigonal areas (*Fig* 182) It must be regarded as indicating a serious alteration in the circulation of the bladder due to compression of its vessels by the close proximity of malignant disease or the inflammatory zone which accompanies that disease ' (Gemmell)

3 A submucous bud of carcinoma appears and gradually spreads (*Plate VIII* D page 180) It is often preceded by pitting and

retraction of the vesical mucosa. It is irregular, nodular and may be partly covered by pus or blood, or exhibit evidence of superficial necrosis. In Chapter XI the appearances presented by vesical carcinomata are more fully described

4 When ulceration is marked, perforation and the formation of a fistula between the urinary and genital passages occurs

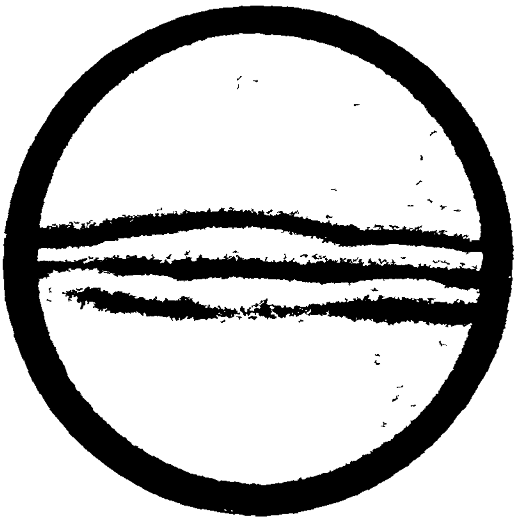


Fig 182 —Transverse ridging of the bladder (*Gemmell*)

The Value of the Cystoscopic Findings as a Guide to the Operability of Uterine Cancer —A normal cystoscopic picture is regarded by many authors (Zangemeister, Popoff Luys, and others) as reliable evidence that no difficulties will be encountered in the separation of the uterus from the bladder. This view however is not universally supported (Schauta Hochloff)

The placing of cases in their correct League of Nations categories by bimanual palpation is admittedly open to error, largely because of the difficulty or lack of precision in distinguishing the actual neoplasm from the inflammatory conditions which so frequently go with it In many instances where the growth is on the borderline between operability and inoperability the vaginal examination is inconclusive The cystoscope may then provide evidence regarding involvement of the bladder which should not be neglected In 130 patients Gemmell recorded the cystoscopic findings and related them to the various stages in the League's classification. His table follows —

Cystoscopic Findings	Number	Stages			
		I	II	III	IV
No changes	43	13	15	14	1
Minor changes	45	13	16	14	2
Transverse ridging	14	3	3	6	2
Œdema	28	1	10	9	8

After a careful follow-up of these 130 patients Gemmell reached these conclusions —

'The more serious bladder appearances are found in association with the more extensive stages of the disease and a higher death rate, though they are no index of the expectation of life in those cases which are to prove fatal

Cystoscopic appearances should be taken into account when deciding to which stage a particular case should be assigned This is especially applicable to cases which are considered clinically to belong to Stage I

In T F Todd s series of 1000 cases of cervical carcinoma 195 were clinically placed in Stage III The cystoscopy revealed bladder involvement in no less than 44 of them—an error of over 21 per cent which of course gravely compromises the prognosis whilst emphasizing the importance of the cystoscopic examination

The cystoscope is valuable also in the follow up of these patients, showing the progress of the cases but the difference between a true recurrence and a post radiation effect is not always easy to make out Post radiation effects are fully described on page 214

Where there is much encroachment of the growth on the bladder radium therapy if used too vigorously may lead to the production of a urogenital fistula It is essential that due attention be paid to the neighbouring organ both as a guide to technique and dosage and for purposes of prognosis (Wade and Band, also Gouverneur and Fabre Heynemann and others)

Fig 183 —Excretion urogram from a patient with carcinoma of the cervix and severe infection Both kidneys and ureters dilated probably partly owing to back pressure and partly of inflammatory origin Kidneys contain numerous small stones The ureters are tortuous

Involvement of the Ureter—Dilatation of the ureter in carcinoma of the cervix is a very common complication of that disease, so much so that one half of the mortality in unoperated cases is said to be attributable to renal back pressure and sepsis with its resulting uræmia whilst autopsy records show an incidence of obstruction in not less than 80 per cent of cadavers and about 50 per cent of these are septic (*Fig* 183) The importance of estimating the state of the upper urinary tract would seem to be sufficiently obvious but this phase is still much neglected though there are signs of an awakening to a realization of its value

The stricture occurs where the ureter lies closest to the cervix and where it traverses the base of the broad ligament. It is therefore constant in position at about 4 or 5 cm. above the ureteric orifice. The cause may be œdema or neoplastic invasion, but it is mostly impossible to decide clinically which is accountable. Simple œdema of the ureter found before treatment is referable to the adjacent tumour, but cervical irradiation itself produces temporary œdema where it did not previously exist and may materially aggravate any antecedent swelling. At a later stage fibrosis may perpetuate the stricture. Todd followed up a small group of patients in whom ureteric dilatation was known to have been present before treatment. Months or years after the irradiation he found evidences of obstruction in about half of them, and he took an unfavourable view of the prognosis.

The incidence of strictures (simple or malignant) present when the patient is first seen varies, as one would expect, with the stage of the disease. Thus Todd found that in Stage II only 3 out of 25 subjects had obstructed ureters, but at Stage IV 10 out of 30 showed dilatation and 9 of these had a completely functionless kidney. The strictures may be unilateral or bilateral, but in many the blood-urea remained normal. Graves and others, in a similar investigation, reached comparable results. An instructive table published by them to illustrate the value of a complete urological study of these patients follows:—

	Total Number	Normal	Obstruction: Uni-lateral	Obstruction: Bi-lateral	Percentage Obstruction
Cystoscopy	67	42	16	9	37·3
Intravenous pyelogram	40	9	22	9	77·5
Retrograde pyelogram	32	6	17	9	81·3
Autopsy findings	87	18	23	46	79·3

Meatoscopy.—According to Wade and Band the first signs of the advance of a cervical carcinoma may be found at the ureteric orifice. In order of gravity these are fixation, retraction, circulatory changes, irregular gaping, ulceration, and formation of nodules. The writer's experience is, however, that changes at the ostium are frequently absent even when the ureter is impassable beyond 5 cm.

Chromocystoscopy registers the effects of renal and ureteric back-pressure quickly and effectively, but is less valuable than an excretion urogram.

Ureteric Catheterization.—When the ureter is strictured and will not take the catheter it must be decided whether failure is really due to the growth or results from one of the causes enumerated on page

330 The catheter may pass smoothly even though obstruction as witnessed by urography exists so that the easy passage of an instrument does not exclude obstruction A smooth passage for the catheter has in Gemmell's experience meant an easy dissection of the ureter at operation From meatoscopy alone it is rarely possible to form any estimate of the ease with which the ureter will be mobilized

Catheterization carries with it the danger of introducing sepsis into the kidney and the production of a pyonephrosis which is a particularly grave matter in this disease Even apart from instrumentation infection accounts for an important proportion of the mortality in cervical carcinoma and in the living ureteric catheterization is said to show infection in 50 per cent of patients It is doubtful if this high incidence is realized by the profession

When obstruction is observed (urographically) it may be countered by the passage of ureteric bougies If the stricture is due to œdema this treatment is frequently successful in so far as it prevents a further advance of the pyelectasis but though its progress is arrested it is unusual to find any actual retrogression of the dilatation The instrument may be removed immediately or may be retained for 24 hours

When cancerous invasion of the ureter is responsible for the obstruction ureteric dilatation is valueless and may even superimpose swelling which will close the stricture completely

Gynaecologists in this country have not yet I believe universally adopted ureteric catheterization in order to assist in the identification and to ensure the safety of the ureter during hysterectomy Damage to the ureter is not very uncommon and this simple preliminary would not only eliminate the risk but probably also expedite the operation proper

Urography —Urograms should be made before and periodically during the treatment of a case to keep the surgeon informed regarding happenings in the urinary tree The retrograde route may be chosen but it is not always open The descending pyelogram avoids all chance of instrumental infection It will frequently show a kidney to be partially or completely functionless but that observation is scarcely open to misinterpretation It will display the condition of the tract before interference and the increase in and degree of obstruction resulting from the œdema of treatment whether that be by radiation or operation but especially the former In favourable cases it will show the regression of the dilatation but in the event of this persisting it may suggest the desirability of treatment by bougies

CHAPTER XX

URETERIC CATHETERIZATION

THE CATHETERIZING CYSTOSCOPE

The catheterizing cystoscope differs from the examining instrument in the addition of special parts for the accommodation and direction of the ureteric catheter The other portions--lighting arrangements, equipment for bladder irrigation, and the optical apparatus—remain identical with the corresponding parts of the examination cystoscope which have been described previously Improvements in the optical apparatus, to which reference was made in the section on the telescope, have benefited the catheterizing model materially, for it is

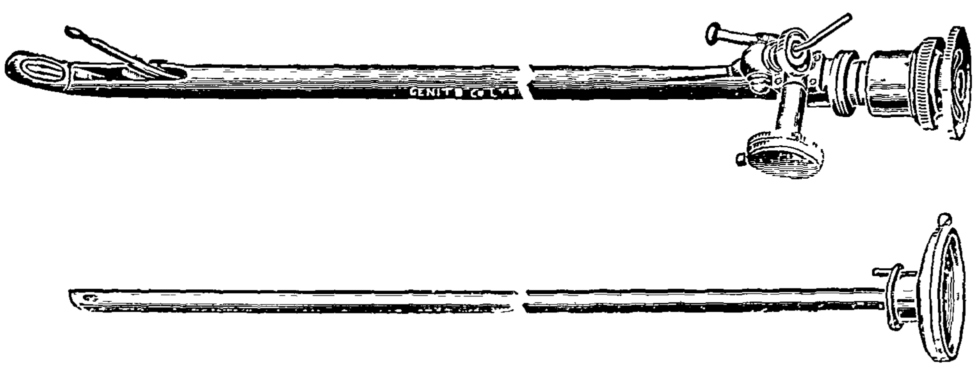


Fig 184 —Single catheterizing cystoscope

now possible to obtain a large and bright field with a small telescope The modern telescope is at the same time sufficiently small to be suitable for the catheterizing instrument and gives optical results which are adequate for the purpose of bladder investigation, so that it has become customary for instrument makers to supply a combination set, containing an examining and a catheterizing sheath, together with a telescope which is common to the two Diminution in the size of the telescope has, moreover, made possible a reduction in the dimensions of the catheterizing sheath, as compared with the comparatively clumsy instruments in use a few years ago, and even so has left increased accommodation for catheters and various operating devices.

The extra space needed for the catheter nevertheless requires a sheath of larger size than that of the simple examination instrument.

It usually corresponds to No. 22 or 23 on the Charrière scale, and in transverse section is oval in contrast to the examining sheath, which is circular. Instruments may be made with the catheterizing parts above or below the telescope—that is, with a concave or convex sheath. The former is the model almost invariably employed nowadays. The latter was the type originally designed and has been superseded for routine work. It is still retained, however, for use in special cases—such, for instance, as contracted bladders or where the ureter opens abnormally close to the internal vesical meatus.

Each of these instruments may be made for single or double catheters. The single catheterizing concave sheath will be described and the modifications necessary for double catheters and the convex sheath will be enumerated subsequently.

The Single Catheterizing Instrument (Figs. 184, 185).—In modern instruments the catheter is accommodated between the wall of the sheath and the upper surface of the telescope, so that the latter forms the inferior wall of the catheter barrel. In obsolete models the catheter chamber was shut off from the telescope by a partition. The omission of this partition effects a reduction in the size of the cystoscope and also facilitates the cleaning of the interior of its sheath. It entails only one minor disadvantage—namely, that the ureteric catheter should not be in position until the telescope is re-inserted after bladder preparation.

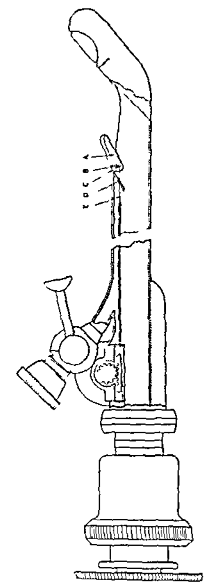


Fig. 185.—Single catheterizing cystoscope. A, Albarran lever. B, Pin on which the lever works. C, Pinhole through which the wires pass—pushing in order to lift the lever and pulling to lower it. D, Sloping guide to direct ureteric catheter towards the lever. E, Wire connecting lever with knob.

The *fenestra* in the wall of the sheath is enlarged to allow egress to the catheter, which emerges at a point just proximal to the position

of the prism A slope is here provided which directs the catheter to the exterior of the cystoscope, and on to a lever (Albarran's lever) which forms a portion of the elevating mechanism By means of this lever the catheter is directed towards the ureteric orifice It is a small grooved metal plate $\frac{5}{16}$ in. long, free at its vesical extremity and lightly hinged at the other end. It is connected by two wires to a pinion handle at the external end of the instrument This handle controls a rack and pinion, whereby the lever can be raised or lowered It is capable of movement through 90°, its axis lying parallel with the shaft of the cystoscope when down and at right angles when fully elevated When lowered the lever does not project beyond the sides of the sheath, and is therefore prevented from injuring the urethral mucosa during introduction.

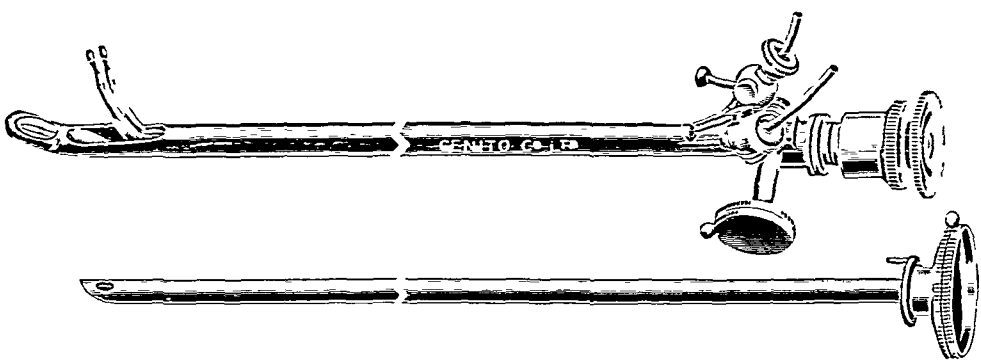


Fig 186 —Double catheterizing cystoscope

At the ocular end of the cystoscope the catheter channel is continuous with a tube about $\frac{3}{4}$ in. long which emerges from the upper wall of the cystoscope. Through this the catheter reaches the surface. The tube is capped by a screw perforated at its centre to allow the passage of the catheter. Beneath this screw is a small space containing a rubber washer, likewise perforated for the transmission of the catheter. When the screw is tightened the washer is compressed against its seating and bulges centripetally towards the catheter, making a water-tight joint similar to the one surrounding the telescope The degree of compression required of the screw naturally varies with the size of the catheter employed On the tube is a tap which is closed to prevent escape of bladder contents when the catheter is not in position, and which must be opened to admit it

The Double Catheterizing Instrument (*Fig* 186)—This differs from the single model in that the catheterizing parts are duplicated throughout The catheters are separated from each other by a partition If not kept apart friction may dislodge the catheter which is supposed to be stationary during the manipulation of its neighbour. The size of the instrument remains at 23 on the Charrière

scale A larger catheter can be employed with the single than with the double instrument

The Swift Joly Instrument —In this model (Fig 187) several excellent modifications are adopted, and the cystoscope has become deservedly popular

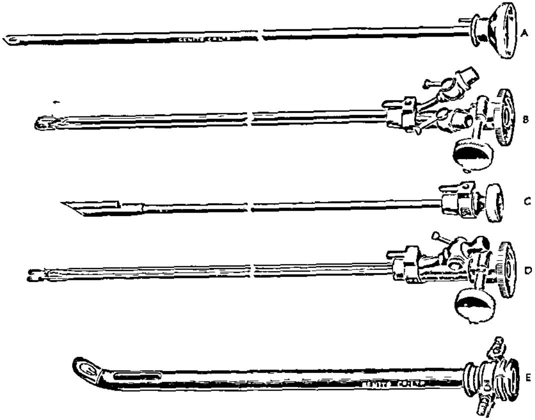


Fig 187 —Swift Joly s catheterizing and operating cystoscope A Telescope B Double catheterizing attachment C Obturator D Operating attachment E Sheath

1 The catheterizing mechanism is separable from the sheath and both unilateral and bilateral fittings are supplied The unilateral model is capable of admitting a No 11 Charriere catheter and with it small scissors and forceps can be employed These catheter fittings are attached to the sheath by means of an expansion at the ocular end which fits snugly into a seating at the corresponding end of the sheath It is locked in position by an interrupted screw or bayonet catch An aperture in the expanded end lies opposite the lower compartment in the sheath and receives the telescope which is held in position by friction

2 During introduction the fenestra of the sheath is occupied by an obturator which is removed as soon as the instrument is in situ

The obturator protects the wall of the urethra from damage by the edges of the fenestra

3 There is no valve at the ocular end, a finger being used to retain the bladder lotion after irrigation until the telescope is inserted A faucet containing a valve is, however, made for use during irrigation (*Fig* 188)

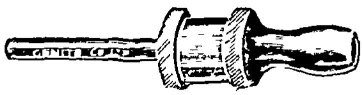


Fig 188 —Andrews' ball-valve faucet for use with Swift Joly cystoscopes

4 An ingenious attachment for retrograde vision, owing its properties to a second prism fixed where the usual window is placed, gives a view of the bladder neck (*Fig* 189) To it is attached an instrument carrier capable of taking a No 6 fulguration electrode for the destruction of tumours in this otherwise inaccessible region

5. All parts can be boiled with the exception of the telescope.*

It is claimed for this instrument that (*a*) It is aseptic in view of being boilable, (*b*) It is possible to change from a double to a single catheter, or a retrograde cystoscope, without removing the sheath

Fig 189 —Telescope and operating attachment of Swift Joly's retrograde cystoscope for examination and fulguration of the internal meatus Note double reflecting prism

from the bladder, (*c*) It is the only instrument in which the operating attachment can be used in conjunction with a retrograde cystoscope.

A 19 Charrière examining sheath can be supplied with this instrument

Buerger's Instrument.—Leo Buerger, of New York, has done much valuable work in the development of the cystoscope and cysto-urethroscope in America His cystoscope evolved from and improved upon that of Tilden Brown It is shown in *Fig* 190 It will be seen that —

1 The sheath and lighting apparatus form one unit introduceable with the assistance of an obturator occupying the fenestra

2 The telescope and operating attachments are combined and form a second unit These two units are assembled and fixed by means of a rotating catch

3 There is no valve

4 Concave and convex sheaths are provided

* A boilable telescope will be supplied if ordered *See also* page 25

5 Retrograde vision can be obtained by rotation of the prism backwards (*see Fig* 26 page 22)

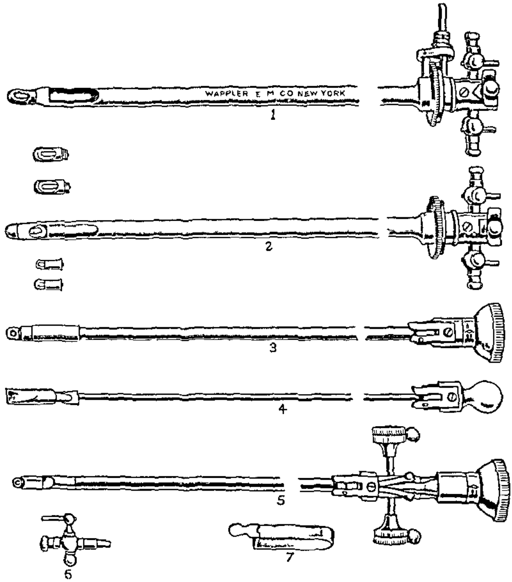
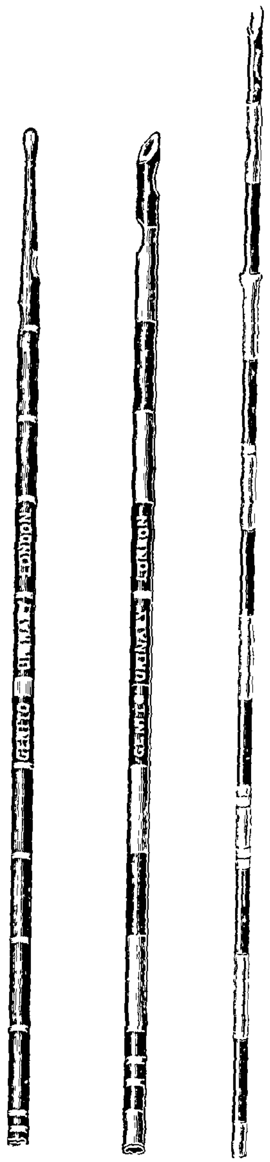


Fig 191 — Brown Buerger combination cystoscope 1 Concave sheath and lamp 2 Convex sheath and lamps 3 Telescope 4 Obturator 5 Telescope combined with catheterizing apparatus 6 Stop cock for irrigation 7 Catheter clip

Buerger does not recommend the convex sheath in routine cystoscopy but claims that it is valuable in close vision work and in contracted bladders

URETERIC CATHETERS AND BOUGIES

Catheters and bougies are made of cotton, linen, or silk thread into which is worked a special form of shellac varnish called 'gum-elastic'. They measure about 30 in. (70 cm.) in length, and correspond in diameter to 5, 6, 7, and 8 on the French scale. Some surgeons use larger sizes, but those mentioned will be found to be most generally serviceable. Many catheters are made in France, so that it is useful to note that in the Beniqué scale the sounds are numbered from 10 to 24, 10 corresponding to No 5 Charrière and 24 corresponding to 12.* A range of sizes is necessary because ureters vary in capacity, both congenitally and pathologically, and also because the instruments fulfil varying tasks, thus, if one is catheterizing a ureter to estimate the renal function, it is desirable to use a large size in order to occupy the lumen as fully as



A B C

Fig 191 —Ureteral catheters A, Olivary ended, B, 'en bec de flute', C, Catheter with collar to prevent leakage

possible, so that there will be no leakage around the catheter and no loss of urine. On the other hand, when some drug is being introduced into the renal pelvis, as in lavage or in pyelography, one desires to avoid over-distension, and therefore a small catheter which leaves plenty of room for leakage alongside it will be selected.

The tip of the catheter is made in several different patterns (*Fig* 191). It may be rounded or olivary, in either of which cases two or three lateral eyes are placed at different levels and on alternate sides in the first inch or inch and a half of its length. In other patterns there is a

* The French or Charriere scale for urethral catheters and urological instruments, other than ureteral catheters, is in common use in Great Britain. It is denoted by the letter "F" or "CH" as 8 F, 8 CH, the figure representing the length of the circumference in millimetres. The French Urological Association has adopted the Benique gauge. It is denoted by the letter "B" as 16 B, the figure indicating the length of the circumference in *half millimetres*. Ureteral

terminal opening which should be combined with lateral orifices in case the terminal one becomes occluded. The terminal opening is generally cut en bec de flute, and this pattern of catheter the writer recommends as being the most serviceable. The disposition of the lateral eyes is of importance for two reasons: (1) They must be so placed as to avoid weakening the terminal portion of the catheter, which is always the part most exposed to trauma by the lever. (2) They must nevertheless be of good size and on opposite sides of the catheter so as to diminish the likelihood of both being blocked simultaneously by contact with the mucous membrane. Behind the terminal of the two eyes in some patterns is a thickening of the shaft of the catheter intended to prevent urine from passing down alongside the instrument. It increases the measurement locally by a degree on the Charriere scale.

Some catheters are divided into centimetres (or sometimes half inches) by alternating light and dark segments of coloration; others are uniformly coloured. At every 5 cm. a ring or rings which are easily recognizable through the cystoscope indicate to the observer the distance that the catheter has proceeded up the ureter. Thus one ring appears at 5 cm., two rings appear at 10 cm., and an extra ring is added for each further 5 cm. till at a distance of 25 cm. from the tip 5 rings occur. At 30 cm. a fresh beginning is made with a single ring which is added to as previously. In some catheters alternate segments are rendered opaque to X rays by the addition of some impenetrable substance. Others are opaque throughout their whole extent. In combination with the X rays these instruments provide valuable assistance in the localization of shadows occurring in or near the line of the ureter.

A correct degree of rigidity is essential, and should be one of the first things looked for when purchasing a catheter. This is, however, a constant feature in the instruments supplied by the best firms, such as Eynard or Gaillard. It must be sufficiently firm to make its way up the ureter without coiling up, and yet sufficiently pliable to lend itself to the movement imparted to it by the lever of the catheterizing cystoscope and to the shape of the ureter without unduly distorting the latter. Too stiff a catheter is liable to push its nose into the mucous membrane of the ureter (*see* Fig. 199, page 330) when it ought to be manoeuvring a curve, and by so doing it will probably

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catheters are generally marked in the Benique scale. In instruments of which the cross section is a true circle the diameter of that circle is equal *to a third of the* scale number, or a sixth in the case of the Benique gauge; thus 9 F. = 3 mm. diameter, 18 B. = 3 mm. diameter. The measurement of the diameter is the method often adopted, but, as indicated, it is true only for instruments whose *cross section* is a true circle.

pick up a fold of mucosa In this way pain, hæmorrhage and injury are liable to occur, and the catheter will be halted

A stilette of brass or steel wire is supplied, and serves the dual purpose of keeping the lumen patent and of preventing bending or kinking. The stilette is removed before use It is very important that the catheter should be kept in an extended position for if coiled up it will retain the curve when in use This curve may throw the tip on one side of the lever, and so displace it from the field of view and render it difficult to introduce into the ureteric orifice

Sterilization of the Ureteric Catheter—The best ureteric catheters, such as those made by Eynard and some of the nylon catheters made in America, can be sterilized by boiling without losing their elastic properties, and this of course, is by far the surest method The catheter should be gently removed from the sterilizer and placed on an aseptic towel to allow the shellac to harden before using At the present time, however, it is not always possible to get the highest grade instruments

When boiling is not permissible the sterilization of the *exterior* of a ureteric catheter may be accomplished by methods similar to those used for gum-elastic urethral instruments After cleansing with soap and water they may be placed in antiseptic lotion, such as carbolic (1–40) or mercury oxycyanide (1–500) Formalin sterilization is preferable and may be carried out in a hot or a cold sterilizer

Apart from boiling, the sterilization of the *interior* of the catheter is difficult on account of its great length and narrow lumen The importance of obtaining perfect sterility of this tube has greatly increased since the practice of injecting fluids into the renal pelvis for lavage pyelography, etc has evolved So long as the flow of the liquid was all towards the exterior there was less danger of infection, but nowadays perfect catheter asepsis is absolutely imperative A catheter which has been used on a septic case must therefore be destroyed The high cost of these instruments, however, forbids the use of a fresh catheter in every case, and where one has been employed on an aseptic kidney it may safely be retained for further use

Before sterilization the patency of the lumen should be proved by flushing it through with a syringe attached to the extremity, thus mechanically removing debris etc The connection shown in *Fig* 192 will be found useful as it is universally adaptable to any syringe or catheter The syringe shown in *Fig* 193 may be employed with it or with the tapering nozzle seen in *Fig*. 261, page 439 Should obstruction prove obdurate, it may usually be overcome by introducing the stilette

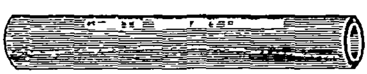

Fig 192 —Thomson-Walker's ureteric catheter and syringe nozzle

The methods used for sterilization of the lumen are —

1 By means of antiseptic lotions driven through the lumen by a syringe as described above

2 A hot formalin sterilizer is illustrated in *Fig* 194 and this is a satisfactory way of obtaining asepsis Prior to placing the catheter in this sterilizer it must be carefully dried both

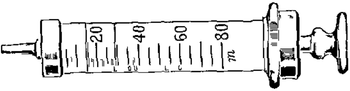

Fig 193 —Ureteric catheter syringe

inside and out as otherwise the formalin acts on and destroys the shellac Dryness of the interior is difficult to obtain The instrument should be attached to a syringe and a current of air blown through it several times It should then be allowed to stand for twenty four hours in a warm dry place in the presence of calcium chloride When dry the end of the catheter is firmly plunged on to

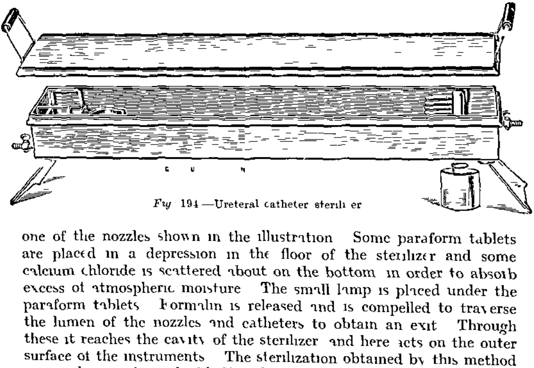

Fig 194 —Ureteral catheter sterilizer

one of the nozzles shown in the illustration Some paraform tablets are placed in a depression in the floor of the sterilizer and some calcium chloride is scattered about on the bottom in order to absorb excess of atmospheric moisture The small lamp is placed under the paraform tablets Formalin is released and is compelled to traverse the lumen of the nozzles and catheters to obtain an exit Through these it reaches the cavity of the sterilizer and here acts on the outer surface of the instruments The sterilization obtained by this method is complete at the end of half an hour The joint between the nozzle and the catheter should be tight so that the lumen is assured of the action of the formalin

Long tubes for cold-formalin sterilization are obtainable (*Fig.* 195). The catheter box (*Fig* 196) serves a similar purpose and has the merit of portability The coil on the catheter though undesirable, is not so acute as to injure it materially The formalin is held in the centrally placed receptacle with the perforated cover Some time before the instrument is required the fumes are allowed to escape from the catheter box in an anteroom through the perforations in the lid which are opened from the exterior by a slide The action of cold formalin should continue for twenty-four hours

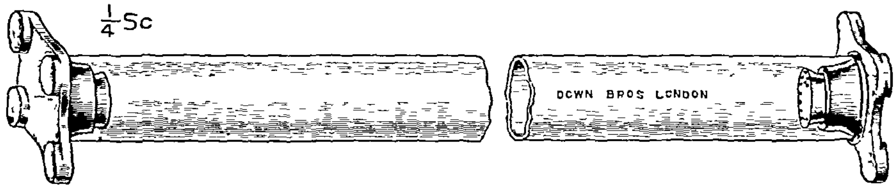

Fig 195 —Glass catheter tube, for storage and sterilization of ureteric bougies and catheters, with formalin container at each end

The best results are obtainable by the hot method, as thereby the interior of the catheter is more searchingly treated than it can be by means of cold formalin or lotions It is doubtful if the vapour comes sufficiently intimately into contact with the whole length of the catheter lumen when cold vapour is employed.

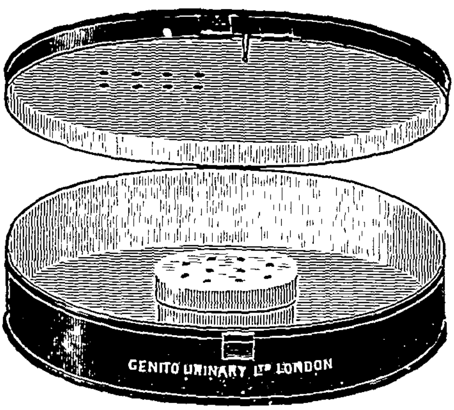

Fig 196 —Everidge's catheter box for ureteral catheters, with formalin container

THE TECHNIQUE OF URETERIC CATHETERIZATION

The details of anæsthesia, bladder preparation, sterilization equipment etc , have been studied in various sections of this book, and are the same for ureteric catheterization as for ordinary cystoscopy The patient occupies the position already described, and care is taken that the pelvis is placed at a convenient angle (*see* page 46)

When the bladder is being prepared through the cystoscope it is preferable to postpone the introduction of the ureteric catheter until the irrigation is finished, lest the external portion of the catheter be soiled by coming into contact with unsterile parts Furthermore, the bladder urine may be septic prior to irrigation, and it would unnecessarily contaminate the catheter as it lay in the barrel During vesical

irrigation the tap on the catheter barrel is closed and is not opened until the introduction of the catheter If the bladder has been prepared by a rubber catheter the cystoscope is passed ready loaded with the catheter the telescope of course being first inserted to form the floor of the catheter barrel

The catheter is inserted as far as is possible without its projecting at the fenestra Attention should then be paid to the washer and the controlling screw must be tightened sufficiently to ensure that the washer is lightly in contact with the sides of the catheter, but yet allows it to run freely backwards and forwards If leakage occurs at this joint the bladder gradually empties itself on to the knees of the cystoscopist Finally a turn should be given to the pinion handle which elevates the lever in order to make sure that it is functioning well The introduction of the instrument into the bladder differs in no respect from that described for the examining cystoscope save that its larger size renders it slightly more troublesome During the whole operation a properly prepared assistant should make himself responsible for seeing that the free end of the catheter does not become contaminated by trailing on unsterile objects

As soon as the instrument is in place it is rotated over and the ureters are searched for They are found by the methods described on pages 64 and 74 (It is presumed that the bladder has already been examined If not a preliminary investigation should be carried out) The cystoscopist now takes the barrel of the instrument in his left hand holding it at a point just in front of the junction of the shaft with the expansion of the optical end Meantime he steadies his left arm by resting the elbow on any convenient fixed point—generally the end of the table His right hand is free to undertake the more delicate manipulations of the catheter and lever Keeping the *ureter in view* the optical end is now raised or lowered until the surgeon *estimates* that the prism is about one inch or if anything rather less *from the* ureteric orifice The instrument still being kept *perfectly steady* with the left hand the right hand now feels for the ureteric catheter and having grasped it gently pushes it forwards so that its *point* advances into the bladder The eye of the cystoscopist applied to the ocular observes its progress across the field and just as the tip is about to pass out of view it is arrested (*Fig* 197 A) The *catheter* occupying this position lies almost parallel to the shaft of the cystoscope and is quite close to the prism It is therefore seen as a *magnified* band crossing the field and having parallel sides Further as the light from the lamp fails to reach the surface presented to the *operator* it appears as a dark unilluminated object

The right hand now passes from the catheter to the pinion handle and gently rotates it through half a turn the surgeon

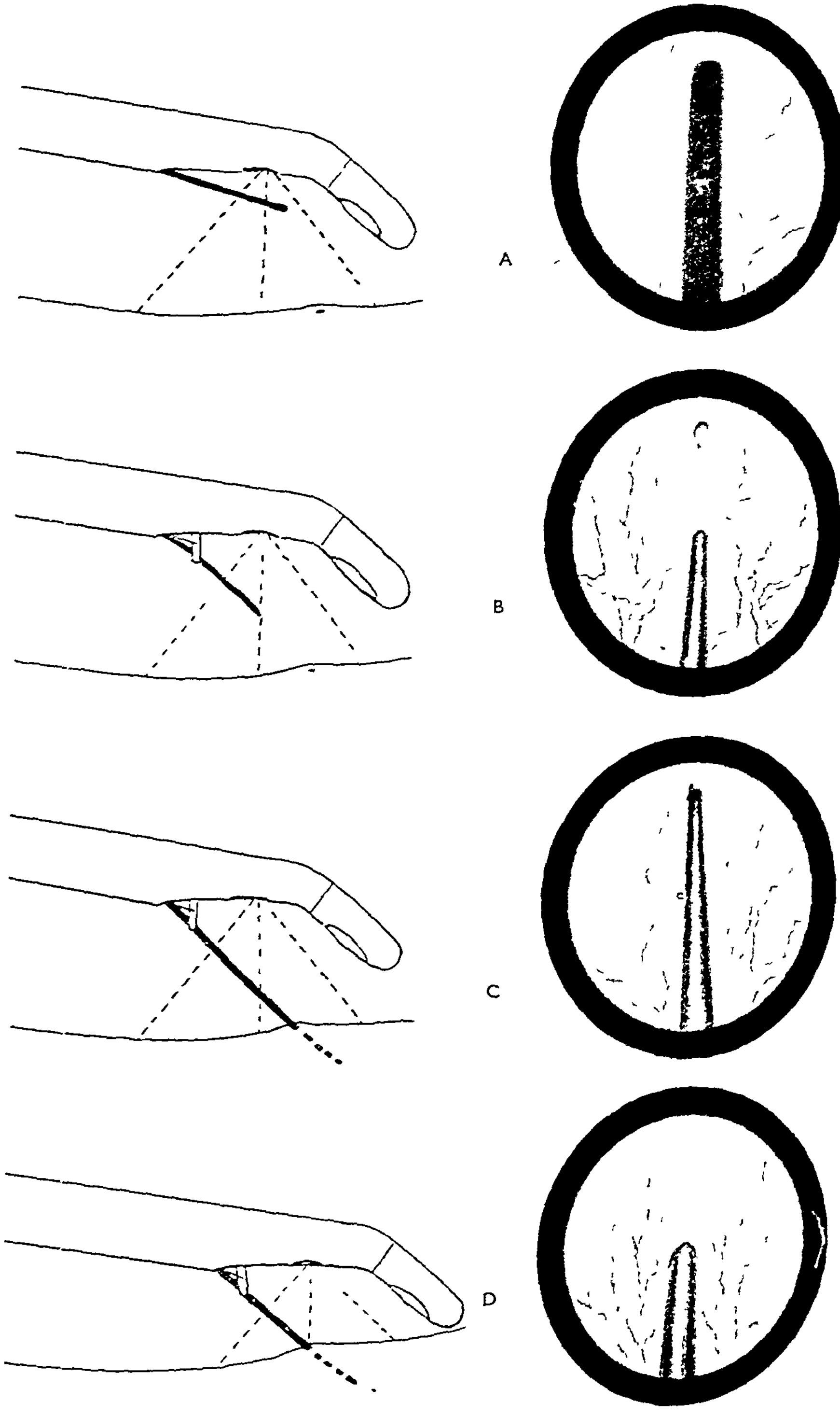

Fig 197 —To illustrate the technique of ureteric catheterization

meanwhile watching the effect produced on the tip of the catheter This is observed to recede and become foreshortened Perspective now makes it appear pointed whilst the surface suddenly becomes illuminated owing to its altered relationship to the lamp The recession of the catheter has uncovered about half of that portion of the bladder wall which was previously hidden by it and if the manœuvre has been accurately carried out its apex should occupy the central point of the field (*Fig* 197 B) It is a matter of importance that the catheter should not be kinked too acutely, for it may thereby be injured (*see*, however footnote on page 329) A suitable angle is found at about 45 If the positions of the catheter tip which have been described above have been accurately followed (that is, the first position being one in which the catheter bestrides almost the whole of the central portion of the field and the second that in which the tip has receded to coincide with the central point of the field) the bend on the catheter will be approximately the correct one—namely, 45° At this angle the relationship of the terminal segment of the catheter to the ureteric orifice facilitates its insertion (*Fig* 197 C)

Now by a slight adjustment of the position of the cystoscope the surgeon brings the ureteric orifice into the upper (distal) portion of the field so that the apex of the catheter is pointing towards it About a quarter of an inch more catheter is paid out care being taken that it moves in the direction of the orifice and that too great a length of catheter is not free in the bladder It is a sign of inexperience to rely too much on the elevating mechanism and the length of catheter When three quarters of an inch of catheter is paid out into the bladder the entrance of the tip into the ureter should be secured by infinitely small adjustments of the position of the cystoscope shaft itself At the stage described it is probable that the tip of the instrument is lying quite close to the entrance so that by a movement of the body of the cystoscope penetration may be obtained (*Fig* 197 D)

The catheter may now be fed quickly but gently forward for an inch or two in order to consolidate the ground gained and then the surgeon should return to the elevating screw and depress the lever as it is no longer necessary and is a menace both to catheter and to the bladder mucosa When this precaution has been taken the catheter may be fed into the ureter as far as is deemed advisable (*see* page 333) and as it runs home the cystoscopist observes the markings on the exterior so that he may know approximately the point in the ureter which the apex of the instrument has reached As the catheter passes into the ureter it elevates the walls of the intravesical portion so as to form a tunnel shaped opening (*Fig* 198) the entrance of which is repelled by the friction of the advancing catheter The cystoscopist

nevertheless should make it his object to cause as little deformity of the ureter as possible, for such deformity means that the cystoscope and the ureter are not in perfect alinement, and unnecessary trauma is occurring By a combined movement of depression and retraction of the peak the salient will be diminished

Fig 198 —Catheter elevating orifice

Occasionally it is found more difficult to catheterize the left than the right ureter, especially is this so in the case of an operator who uses his right eye. The reason is that the cystoscope is too near the median line and is viewing the orifice as it lies on its side The catheter therefore is working on an incorrect line, and unless it happens to catch the outer lip of the ureteric orifice, is liable to slip past the opening The trouble is rectified if the ocular end of the cystoscope is swung further over towards the patient's right thigh and rotated so that the beak faces downwards The catheter thereby is brought more vertically over its work and more into opposition to the ureter

The writer uses the method of handling the cystoscope above described for the catheterization of each ureter Some cystoscopists, however, recommend that the hands be disposed as described above when dealing with the right ureter, and that an interchange be adopted in the case of the left There is little, if any advantage to be gained by so doing, and the hands have to be doubly trained. Gorodichze and Hogge have described and figured a complicated grip which has gained a certain popularity. In their method the one hand holds the barrel of the cystoscope between the little and ring fingers, and the index finger and thumb of the same hand control the deflecting mechanism The other hand inserts the catheter This technique requires a good deal of practice, and when acquired the movements—particularly of the cystoscope itself—lack the delicacy which can be imparted in the method described above

The Removal of the Cystoscope—When the catheter is being left in situ for ureteric drainage the cystoscope must be removed

The light should first be switched off and the deflector lowered The faucet is inserted and all the urine except about 2 oz is withdrawn This quantity I generally leave in the viscus in order that when the catheter is pushed forward into it there may be a certain amount of space to accommodate it The cystoscope is next held steadily whilst the catheter is paid into the bladder until its end has almost disappeared from view into the barrel Having rotated it on its long axis so that its beak looks upwards the cystoscopist now withdraws the instrument As soon as the fenestra appears at the external meatus the catheter is seized in the left hand in order to prevent its further removal from the urinary passages The short urethra of the female makes it easy to obtain a hold on the catheter at an early moment before the slack in the bladder has been taken up In the male the penis should be pressed back to shorten the urethra The catheter is now withdrawn completely through the barrel

Catheterization of Both Ureters—In the catheterization of both ureters a double catheterizing cystoscope may be employed or after one ureter has been catheterized and the cystoscope withdrawn, the instrument may be reloaded and the second ureter catheterized The disadvantage of the double catheterizing cystoscope is that with an ordinary bore instrument the larger sizes of catheter cannot be employed Against double catheterization with a single catheterizing instrument is the fact that it involves the use of the cystoscope when the urethra is already occupied by a ureteric catheter This difficulty is particularly felt in the case of the male Larger catheters can however be employed and there appears to be a tendency in this country to discard the double instrument in favour of the single

Some means of distinguishing the right from the left catheter must be adopted For this purpose instruments of different colours or types may be employed or a label may be tied on to act as an indicator

DIFFICULTIES OF URETERIC CATHETERIZATION

Catheterization of the ureter is generally a simple operation in practised hands and when the bladder is normal In diseased states it may be easy difficult or impossible Trouble may be encountered as a result of a large number of conditions most of which are pathological in origin The majority of these have been fully described in other sections of this book and only require a brief mention here

1 **Introduction of the Cystoscope**—Difficulty is sometimes encountered in the introduction of the catheterizing cystoscope because its larger size renders its progress along the urethra less easy than that of the smaller examining instrument

2 **Vesical Conditions**—The chief causes of difficulty arising in the bladder are cystitis and covering of the orifices

Cystitis—The difficulties experienced in freeing the organ from pus and blood and in overcoming its irritability have been dealt with in the section on bladder preparation Even when efficiently prepared a very irritable organ may inopportunely empty itself during ureteric catheterization A red and swollen mucosa may effectively conceal the ureteric opening, which in severe cystitis may be very difficult to find Simple cystitis is less troublesome as a rule than tuberculous cystitis, where reduction in capacity, and irritability, redness, œdema, ulceration, and hæmorrhage may all contribute to impede ureteric catheterization

Catheterization is possible when the bladder will hold 2 oz of fluid, but if the capacity is further reduced it becomes increasingly difficult or even impossible For extremely small bladders Buerger recommends his convex sheath In this instrument the catheter comes into very close approximation to the ureteric orifice owing to the direction of the curve of the beak The same instrument may be found valuable when dealing with an orifice which receives insertion near the vesical neck, though the cysto-urethroscope may then be preferred

Hidden Orifices—The ureteric orifices may be hidden by a growth or a stone Their discovery, however, is not important in these diseases because treatment will be directed to the bladder and not to the kidney Blood and pus constitute an obstacle to ureteric catheterization when they are present in quantity, either by occupying the vesical sump and covering the orifices, or by rendering the medium turbid For their treatment *see* Chapter III

3. Prostatic Disease.—In both simple and malignant enlargement of the prostate separation of the urines is unnecessary except in rare instances In the former, however, I have had to undertake it owing to there being concomitant disease in the kidney In minor degrees of hypertrophy the operative difficulties are not greatly increased, but when the median prominence is considerable it may be difficult or impossible to reach, perhaps even to see, the openings of the ureters (*see* Chapter XVIII)

Tuberculosis occurring in the prostate frequently complicates a similar lesion in the kidney Minor grades of the disease are often present even though quite unrecognizable In any case they would not contra-indicate cystoscopy as they are apparently not injuriously affected by it Urethral instrumentation is dangerous in advanced prostatic tuberculosis, as it may fan the disease to renewed activity, whilst difficulties may arise in the introduction of the instrument owing to the urethra being narrowed (*see also* page 281)

4. Uterine Conditions.—Changes produced in the bladder by physiological and pathological enlargements or by displacements of the

uterus may in some instances impede this operation. They have been described at length in Chapter XIX, where the difficulties encountered in ureteric catheterization have also been discussed.

5. Ureteric Conditions.—

The Meatus.—The ureteric opening may be difficult to find even though *normal*. It may be surrounded by folds and recesses of similar appearance to itself amongst which it remains inconspicuous. Often an abnormal distribution of blood-vessels occurring around it may confuse the eye, or the rich vascularity of the trigone may extend up to overlap and obscure the orifice. The missing opening may sometimes be found on the external aspect of the ureteric bar, and the beak of the cystoscope must be manœuvred further afield towards the lateral recess in order to bring it into view. To catheterize it the fenestra must then be rotated inwards so as to face its mouth. The operation may be difficult, but frequently the anteriorly lying lip of the orifice gives way before the pressure of the ureteric catheter and thus uncovers the entrance.

Actual *displacement* of the meatus sometimes occurs, abnormal situations on the ureteric and interureteric bars being the most common (*see* Chapter XXIII, page 410). The history of urine coming away from the rectum or vagina, or dribbling away from the urethra apart from micturition, would suggest an abnormal termination. Occasionally, when a *double* ureter is present, only one has been catheterized, the other having escaped recognition. Faulty observations would then, of course, be made in renal examinations.

The ureter may be actually *absent* (*see* Chapter XXIII, page 397). A very careful and prolonged search should be made before deciding that this is so, especially when the bladder is diseased, and indigo-carmine should be employed to assist in its identification before the search is abandoned. Excretion urography would confirm the absence of a functioning kidney.

One of the commonest minor abnormalities to be observed is an exaggeration of the little salient on which the ureter normally emerges. It requires greater precision on the part of the operator to strike an orifice so situated. The catheter must dip straight home without fouling the vesical floor. A puffy condition of the ureter of inflammatory origin may give rise to a similar elevation. An extreme degree of flexion should be given to the catheter in these cases by means of the lever* in order that it may come directly over the orifice. If this method does not succeed, the tip of the catheter may be

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* It may be pointed out that, though the elevating mechanism of the cystoscope can be raised through a right angle, only a portion of this angulation can be communicated to the catheter, which, as may be demonstrated extravesically, passes obliquely from the distal end of the fenestra to the tip of the lever.

allowed to rest on, and to depress, the margin of the elevation just in front of the opening, and then as it is advanced it can generally be persuaded to enter the tube

In the presence of a *ureterocele*, or of a ureter opening into a *diverticulum*, catheterization is impossible Occasionally an orifice is *congenitally so small* that it will not admit the finest bougie When this happens I have sometimes met with success by employing a stiletted catheter, the additional rigidity of this instrument being sufficient to overcome the friction of the contracted opening As the stenosis is strictly localized to the termination of the ureter, the remainder of the tube being of normal or more than normal size, there is little likelihood of much harm resulting

The Ureter Proper Obstruction—A ureteric catheter may be held up by a stricture, a stone, or a growth, all of which are dealt with in the relevant chapters But a much more common obstruction is a fold of ureteric mucosa which the catheter tip picks up (*Fig* 199), and the most common site is the lowest two or three inches of the tube The intravesical segment of the catheter is then seen to become arched (*Fig* 200) It may or may not be possible to free it, but if it does not quickly yield, the following remedies have been recommended —

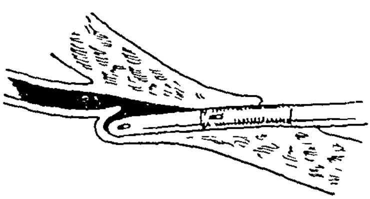


Fig 199—Ureteric catheter caught in a fold of mucous membrane

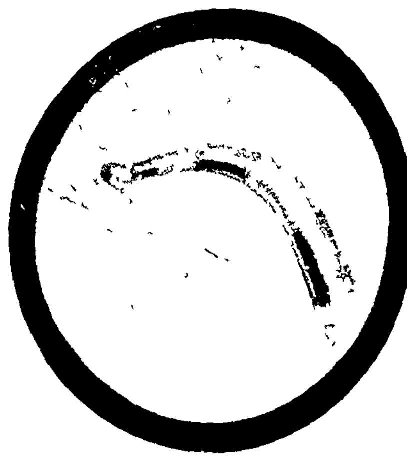


Fig 200—Catheter obstructed in ureter, intravesical portion bends up

a Occasionally the trouble is caused by faulty alinement of the catheter with the ureter, and careful readjustment may be followed by success

b A movement of rotation on its long axis should be imparted to the catheter so that it may free itself from the impeding fold

c. A smaller catheter may be employed, and, failing this, a larger one or one with a differently shaped tip may prove successful

d Sterile lotion, or, better still, parolein, may be injected through the catheter This will sometimes distend the channel and disengage the catheter tip

e Varying the quantity of vesical fluid sometimes produces the desired effect A reduction in distension will diminish the curve of the ureter lying immediately behind the bladder—it should be quite easy to catheterize in 4 oz of fluid On the other hand over distension may drag on the intravesical ureter and occasionally succeeds where other methods have failed

f Alteration in the position of the patient sometimes overcomes the trouble The catheter tip naturally catches when manœuvring a bend in the tube and it is therefore more common in women—owing to the more pronounced curve of the ureter—than in men If the lumbar spine is hyperextended sufficient straightening may be effected in the ureter to allow the instrument to progress If this is not enough the pelvis is raised and the shoulders are dropped The weight of the intestines is thereby taken off the upper surface of the bladder allowing that viscus to rise and in addition the kidney moves towards the diaphragm and straightens out the ureter

Even if none of the above expedients succeeds the catheter may yet collect urine from the kidney The surgeon should examine the portion of the instrument which is under his view in the bladder to see whether any of the eyes are exposed If so not only will bladder fluid drain away by the catheter but also some of the renal secretion will be lost in the bladder There will thus be an interchange of fluids If no eye is visible the catheter may be left in position but it is then advisable to leave the cystoscope also undisturbed as its removal might withdraw a little of the catheter It also gives the surgeon the opportunity of inspecting the catheter from time to time to see that it is still in the ureter Marion recommends that some methylene blue be introduced into the bladder to show whether there is any leakage through the catheter

DANGERS OF URETERIC CATHETERIZATION

Sepsis—When ureteric catheterization was new and was first provoking discussion the possibility of introducing sepsis into a healthy ureter aroused much anxiety in the minds of the profession This is natural in view of the fact that many catheterizations take place across infected bladders where for example unilateral pyogenic or tuberculous disease of the kidney has started a similar condition in the bladder the other kidney being still healthy It is generally the healthy ureter which requires catheterization Experimental work carried out by many observers has now established the fact that the danger of infection is inconsiderable The ureter has been found to behave in the same way as does the bladder to sepsis artificially introduced into it and in the absence of injury or obstruction it will quickly throw off the infection In 1913 Hess described the

bacteriology of bladders immediately following cystoscopy and showed that in the first few days following instrumentation bacteria could usually be found in the bladder that they produced neither symptoms nor signs of cystitis and that they quickly disappeared

Albarran was the pioneer in experiments on the ureter, and demonstrated that the injections of pure cultures of organisms into the ureter was harmless, provided that the ureter was not damaged or obstructed Sampson and other workers have confirmed his experiments Albarran showed however, that if injury or obstruction exists the organisms then obtain a foothold It will be shown immediately that hæmorrhage is common after ureteral catheterization, indicating some degree of trauma which might predispose to sepsis Nevertheless experience demonstrates the rarity with which renal or ureteric inflammation supervenes This will not however, excuse slackness in our aseptic ritual The ureteric catheters should be kept *out of the cystoscope in septic cases until the bladder has been cleansed When the ureteric catheterization is taking place the surgeon must try to introduce the tip into the orifice without allowing it to be soiled by unnecessary contact with the bladder,* whilst it should be advanced slowly and gently in order to avoid injury to the ureter. Only catheters which are smooth and well preserved should be employed

When catheterizing across an infected bladder in order to ascertain the functional value of a kidney it is rarely necessary to advance the catheter as far as the renal pelvis A specimen will be obtained if it is introduced only a sufficient distance to ensure that it does not slip out again Nevertheless permanent damage is undoubtedly done on occasion by the catheterization of an aseptic ureter across an infected bladder, and the cystoscopist would do well in such circumstances to pause and ask himself whether any useful purpose will be served by such catheterization or any information acquired which could not equally well be got from meatoscopy the carmine test and excretion urography The writer has long held that catheterization of a healthy upper tract across a septic bladder is too light-heartedly undertaken by some surgeons *

Hæmorrhage.—*Microscopical* hæmorrhage is the rule following ureteric catheterization, generally it is insignificant in quantity It has this importance however that it renders the operation valueless for the detection of the origin of renal hæmaturia—which is unfortunate

* To illustrate this danger more than one case may be recalled in which one kidney has held secondary stones caused by urea-splitting organisms Following catheterization across the necessarily septic bladder the previously healthy kidney promptly started producing stones of a similar kind See also remarks on catheterization of the healthy ureter in tuberculous disease (page 126)

is often microscopy also fails, owing either to the absence of hæmorrhage at the time of operation or to its being insufficient to be appreciated by the eye as it emerges.

Macroscopical hæmorrhage may occur and may continue for a day or two. Occasionally it is copious enough to cause colic from small clots passing along the ureter. The most marked instances are seen when the instrument has been passed as far as the renal pelvis, and probably result from bruising of vascular papillæ. It is, however, rarely severe, but its occasional presence should be kept in mind, and special gentleness should be exercised when the tip of the catheter is approaching the renal pelvis.

Degree of Advancement of the Catheter.—From what has been said in the preceding paragraphs it will be seen that the catheter should not be advanced to the kidney unnecessarily for fear of causing hæmorrhage or sepsis. For the estimation of renal function, and especially where a septic bladder has been crossed, only a short length is necessary. When, however, the catheter is employed for excluding ureteric obstruction, it must be advanced right to the kidney. Also for pyelography it is customary to push the tip to the renal pelvis, though satisfactory distension is usually obtained, even when the catheter is obstructed in the lower ureter, if necessary by elevating the buttocks and allowing the solution to gravitate to the kidney.

CHAPTER XXI

STONE IN THE URETER

DIAGNOSIS

In the diagnosis of ureteric calculi the principal methods employed are (I) *Radiology,* (II) *Ureteric meatoscopy,* (III) *Ureteric catheterization,* (IV) *Urography*

I. RADIOLOGY

The diagnosis of a ureteric stone made by the X rays requires confirmation in all cases This is especially true of stones within the limits of the bony pelvis Shadows in this area may be very deceptive and demand much care in their interpretation The radiographic evidence may be imperfect in two opposite directions —

1 It may *fail to show* a stone when one is actually present There is some discrepancy in the figures given by various writers of the percentage of failures to demonstrate a calculus in the X-ray diagnosis of ureteral stone Braasch states that a correct diagnosis is made radiographically in only 60 per cent of cases, whilst Lange considers it possible to detect 95 per cent of stones Kummel thinks that calculi of all sizes and of any composition should be detected, and Kretschmer (1942) in a series of 500 patients reported 95 79 per cent of positive findings These latter opinions are contrary to common observation Merritt, averaging a series of statistics, arrived at the conclusion that there are about 75 per cent of positive findings by radiography, which agrees approximately with one's own experience. It is obvious that the debit side in this account does not include cases in which the diagnosis of stone fails by all methods, but only those where the subsequent passage of the stone or its discovery on exploration proves one to have been present To this extent, then, the debit side must be augmented Failures to the extent of 25 per cent may be considered important, though it should be observed that it is the small stone which is likely to be missed and also to be evacuated naturally. In 15 cases (Geraghty and Hinman) where the X rays missed the stone the calculus was subsequently passed in 7, in 6 it was diagnosed by the wax-tipped catheter, and in the others by exploration

Sometimes a stone shadow is present but remains unidentified Peterson and Holmes in 100 cases found 21 in which the stone was

not discovered radiologically When the stone was proved by other means a re examination of the film demonstrated a recognizable stone in 17 of the 21 cases Failures occur with very small stones stones permeable to the rays (uric acid pure cystin and xanthin) and with faulty radiographic technique The cystoscopic features will be valuable under such circumstances

2 On the other hand an extramural shadow in the area of the ureter may be *mistaken for a stone* Fenwick and Kidd investigated 30 bodies and found the following to be the most common fallacies phleboliths lymphatic glands undergoing calcareous changes patches of atheroma in the blood vessels, and appendical or intestinal concretions To these may be added " calcareous deposits in old scars or chronic inflammatory tissue, or on ligatures from a previous operation or calcareous deposits in the seminal vesicles (*see Fig* 204 page 342) intestinal contents such as scybala foreign bodies in the bowel (Blaud's pill etc) fæcal matter coated with bismuth calculi in the appendix and enteroliths (Thomson Walker)

Phleboliths or vein stones are the most fertile source of difficulty and their great frequency increases their surgical importance They are found in one of every five subjects over thirty years of age Little was known of vein stones till the discovery of the rontgen ray but after that it took a period of ten years (1908) before the origin of the shadows seen in so many plates could be determined—an interval in which many errors of diagnosis were made In 1924 Culligan examined 1555 consecutive pelvic plates from the Mayo Clinic and found phleboliths in 39 per cent The average age of these patients was 37 years the youngest being 16 The sexes were affected in the proportion of 3 men to 2 women Anything from one to twenty shadows might be observed and in nearly half the cases they were bilateral Phleboliths are usually rounded though occasionally oval They are rarely larger than a pea have good and homogeneous density and sharply cut margins They occupy the pelvic area (vesico prostatic venous plexus in the male pampiniform plexus in the female) and therefore invariably lie in the ureteric environs When multiple they often lie in chains but a line joining them up will not correspond to the line of the ureter If ovoid their long axis often corresponds with that of the ureter but multiple shadows will probably have varying axes On chemical analysis phleboliths are found to consist mainly of the phosphates and carbonates of calcium and magnesium (Rokitansky and Balogh) and they are very constant in composition

Calcareous glands (*Fig* 201) are generally seen along a line corresponding to the mesenteric root They are commonest in the right iliac fossa and may frequently be found as low as the upper margin of the great sacrosciatic notch being rarely seen in the pelvis

Fig 201 —Ureteric stones Right renal pain of ten months' duration A, Shows numerous mottled shadows on both sides of the spine (? calcified tuberculous glands in the mesentery) and two elongated shadows in the line of the ureter B, Lateral view the mottled shadows lie anteriorly and the two elongated shadows are still in the line of the ureter C, Retrograde pyelogram the opaque fluid envelops the suspected ureteric stones and also outlines a severely dilated pelvis The suspected stones are confirmed and differentiated from the shadows of calcified glands

They are usually larger in size than an average ureteric calculus, often multiple and occur in groups whilst their shadow has an irregular edge and is very uneven in density and mottled

Various methods have been devised to supplement the X rays and to confirm the presence and effects of ureteric stones Of these the most important are the shadow casting bougie or catheter pyelography and ureterography, and the wax tipped bougie which are dealt with later

II URETERIC MEATOSCOPY

Ureteric meatoscopy may or may not provide evidence of the descent of a stone but as a rule there is some recognizable change, which may take the form of (1) *Alterations in the appearance of the orifice* (2) *Changes in the character and speed of the act of ejaculation and in the nature of the efflux*

1 **Appearance of the Meatus**—Even when a stone first enters the ureter some change is observable at the meatus such as *œdema* of the orifice and rigidity If the stone halts in its downward progress these alterations probably fade away till it moves again They become more pronounced when the calculus enters the lower ureter the meatus becoming increasingly rigid and patulous In many examples a rampart surrounds the opening or numerous radiating folds choke the central ostium which is with difficulty discerned The swelling may spread to the trigone and interureteric bar In severe cases the whole trigone is involved At other times especially when the stone is approaching the exit bullous œdema occurs large spawn like masses occupying the situation of the ureter In some infected cases in the writer s experience the ureter has prolapsed into the bladder like an everted coat sleeve and appeared as a tower like structure the orifice being situated at the summit (*See also* Chapter XIV page 241)

Hæmorrhages occur around the meatus (*Plate VIII* A and B) At first and especially when the calculus is high up they are minute multiple and punctiform They are situated chiefly over or near the intramural part of the ureter the mucosa appearing to be stippled with bright red dots At other times stellate hæmorrhages which are larger but less numerous may be observed Later gross extravasation takes place and may occur above or below the ureter more commonly the former The changes are more pronounced with spiculate stones than with smooth ones

When the vesical section of the ureter is encountered the œdema and ecchymosis greatly increase and a fusiform prominence corresponding to the underlying calculus may appear above and external to the orifice The stone may halt here and in rare cases ulcerates into the bladder or it may present at the meatus where it appears as

a dark or glistening object surrounded by a collar of œdematous mucosa (*Plate XIII* C) When the stone escapes into the bladder cavity its presence there will be obvious cystoscopically (*Plate XIII* D), together with the bruised, prolapsed, and possibly lacerated ureteric orifice The meatus soon commences its return to the normal, and in the course of a week or two all signs of damage have usually vanished In a few instances irregularity and scarring, together with either dilatation or contraction of the ostium, remain. The likelihood of permanent damage to the meatus is slight but is increased by the passage of multiple calculi Occasionally when a stone occupying the intramural ureter ulcerates into the bladder a permanent false orifice may be left

2. The Efflux.–Alterations in the normal characters and frequency of the efflux are various, according as the stone is impacted high or low or obliterates the lumen completely or only partially, but the wide variations in periodicity and volume which healthy organs present complicate the recognition of any deviation from the normal When

PLATE XIII

A, Stone descending ureter Hæmorrhage subjacent to orifice B, Ureteric stone, ecchymoses around ureteric bar Orifice small and slightly œdematous, trigone prominent C, Stone presenting at orifice A rampart of œdematous mucosa surrounds the orifice, which is slightly everted D, The same stone seen in the bladder after extrusion E, End of broken catheter in the bladder Slight phosphatic deposit Cystitis F, Tip of hat pin perforating apex of bladder Slight cystitis

swollen, the lips of the meatus are incapable of their usual range of contractility, and appear torpid and immobile

The *frequency* of the ejaculation may be increased or decreased Increase is noticed when the stone is recently impacted and irritation is marked After the obstruction has been present for a time, and especially when dilatation of the kidney, with or without infection, is in progress, the movement becomes feeble When the stone is high up the ureter the efflux is vigorous and copious, but when it has descended to the lowest segment the output is lessened and enfeebled

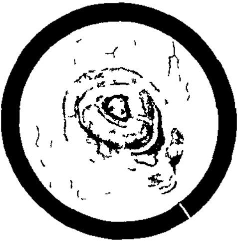
The *quantity of fluid* may be greater or less than the normal. When the duct is *completely* occluded no fluid can escape and ineffectual muscular contractions may be witnessed An absent efflux is made more striking if indigo-carmine is issuing from the opposite ureter. Old-established stones as a rule obstruct the ureter only *partially*, and in the oldest examples channels may be seen on the stone along which the urine has trickled which undoubtedly saves many kidneys from the full effects of back-pressure A good example of water channels on a stone is seen in *Fig* 210, page 348, but here the kidney had suffered severely When the block is incomplete varying amounts

PLATE XIII

STONES DESCENDING THE URETER FOREIGN BODIES IN THE BLADDER

A

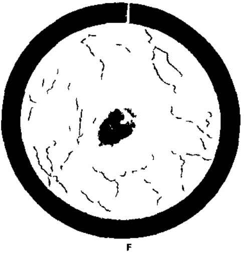
B



C

D

E



F

of urine may be emitted proportionate to the extent of the obstruction and that of the renal damage It may be below the normal but when there is chronic aseptic nephritis from back pressure combined with a fairly permeable ureter, it may equal or even exceed the normal Fullerton made a study of diuresis in cases of ureteric calculus and stated on the basis of some hundreds of observations that there is a definite reflex polyuria on the affected side which passes off when the stone is got rid of The jets follow one another in more rapid succession than on the opposite side and the quantity in each jet is larger in amount The specific gravity of the urine is estimated by glass beads, and is found to be proportionately reduced Thus it may be 1005 or less on the affected side as against 1015 to 1030 on the healthy side Fullerton placed much reliance on these phenomena in diagnosis With obstructions which are incomplete it will almost invariably be found that the output of indigo carmine is delayed and its intensity is diminished

The *efflux* may be clear and normal or may be blood stained from the trauma to and œdema of the ureter When infection occurs pus in varying quantity may be observed It may be small in amount and scarcely evident or may be copious (*see* page 367) The worm like stream shown in *Plate XII* B page 368 came from a calculous pyonephrosis Stone bearing ureters are no exception to the rule that obstructed channels are specially susceptible to infection If infection persists after the stone has gone it interferes with the expected recovery from dilatation of the proximal ureter and the pelvis

III URETERIC CATHETERIZATION

Sounding the Ureter for Stone—When a catheter or bougie is passed along a ureter containing a calculus it may be arrested (*see Fig* 206 page 342) when its intravesical portion will be seen to curl up (*see Fig* 200 page 330) Efforts to induce it to pass may or may not be successful In many instances however the instrument negotiates the stone without the slightest hitch noticeable to the surgeon and its subsequent progress along the canal is just as smooth beyond the stone as it was prior to encountering it The temporary or final arrest of the bougie and a grating sensation as it rubs against the calculus may however be regarded as of diagnostic significance The writer does not attach too much value to these signs Even when the catheter is held up it does not follow that a stone is responsible as the stoppage of instruments is not peculiar to stone bearing ureters (*see* page 330) This is especially true of the pelvic ureter with obstruction higher up it is more significant Further it is quite rare to experience the sensation of friction between the stone and the catheter

Auscultation of the Ureter.—This is of historical interest, as Newman employed a metallic sound which was connected to an earpiece worn by the operator It was supposed to carry to his ear the sound produced by the impact of its metal tip on the calculus Councill (1945) still uses "a hypersensitive electrical instrument which by variations in sound amplitude registers the presence of a stone in the ureter on contact"

Wax-tipped Catheters.—Howard Kelly introduced his wax-tipped instruments in 1895, before the introduction of X rays, and his method has to some extent survived the competition of the latter It depends upon the fact that when the wax encounters the rough exterior of the calculus its surface is scratched. The coat is composed of "dental wax and olive oil mixed together and melted in the proportions of two parts wax and one part oil . . This is poured *into an open bottle holding an ounce, or into a test-tube, where it quickly solidifies The waxing of the catheter is carried out by first* melting the wax in the bottle and then dipping the point of the catheter into it, taking care not to occlude its eye The wax should be distributed in an even smooth coat It hardens on the catheter immediately" The wax can be applied to the catheter at various places according to choice, the tip being selected in the olivary instruments, or a spot immediately behind one or more of the eyes It has been suggested by Sampson that the whole of the catheter should be waxed so that the position of the stone may be judged by the extent of the scratching In searching for scratches the eye should be assisted by a hand lens

At first the method could be used only in the female and with the Kelly open-air cystoscope, as the wax receives a flat facet from contact with the lever or other metal parts if employed with the indirect cystoscope Hinman and Keyes, jun , have paid much attention to this means of diagnosis and have devised ways of using it in the male and with the prismatic cystoscope Several methods have been employed The wax-bearing catheter may be introduced into the bladder first, and then threaded backwards into the cystoscope It is possible then, with care, to manœuvre the waxed end into the ureter without contact occurring with metal surfaces Another way is to introduce two catheters into the bladder, their tips covered by a single soluble capsule One of the catheters is wax-tipped, the other not They are threaded backwards into a double catheterizing cystoscope, and when the latter is introduced into the bladder the capsule is pushed away by the second catheter and left to dissolve in the vesical fluid The wax-covered instrument is now fed into the ureter

Keyes has shown that these complications are unnecessary, for the flat facet produced by the metal is easily distinguished from the

scratches of a stone. The catheter is threaded backwards into the cystoscope and the wax tip is gently placed in the barrel. When the cystoscope has been introduced into the bladder the catheter is projected beyond the end of the lever before the latter is elevated so as to avoid bruising. Before it is introduced into the ureteric orifice the surgeon examines the wax surface as it lies in front of the cystoscopic fenestra, using the magnification of the lens in place of the above mentioned hand lens. He makes a mental note of the surface peculiarities on the bulb, rotating the catheter on its long axis in order to bring all sections into view. The catheter is manœuvred into the ureter by manipulation of the cystoscope itself, the catheter remaining immobile in the sheath until engaged in the orifice. It is now passed up the ureter and withdrawn. It is again inspected under cystoscopic enlargement for scratches or other irregularities. It is withdrawn from the bladder *following* the cystoscope so as to avoid contact between the two, and is now examined with the hand lens.

By this method a positive diagnosis can be arrived at in some cases where the X rays have failed to show an existing stone. Stones may, however, be missed by this method also, as shown by Geraghty and Hinman, and also by Keyes. The former nevertheless consider that this is the most accurate method of detecting ureteral calculi.

Shadow casting Bougies and Catheters.—These are the most valuable accessory means of diagnosis at our command. When introduced along the ureter and exposed to the rays they show the exact situation of that tube and whether or not the suspected shadow coincides (*Figs* 202–204). This gives important evidence of the relationship of the two structures. If further testimony is desired, stereoscopic plates may be taken, or, as suggested by Kretschmer, two exposures from slightly different positions may be given in order, if possible, to divorce the two shadows (*Fig* 205). Occasionally none of these manœuvres is successful in suspicious cases, and Bransford Lewis has recommended the passage of a rigid instrument, as for instance his dilator shaft, which straightens out the ureter, making it take a different course that separates it from phleboliths and other shadows. The stiletted catheter may sometimes serve the same purpose. If the instrument is obstructed by the calculus the shadow of the latter will be seen to cap that of the former (*Fig* 206).

If, prior to the passage of the catheter, a plate be exposed whilst the patient is on the cystoscopic table, and a second be taken immediately after catheterization, the patient not having moved, the stone's position on the two negatives can be compared. Pozzi and Proust have shown that a second photograph will indicate that the instrument has driven the stone up the ureter to a greater or less extent.

Fig 202—Two stones in ureter Relation of shadow to ureter made evident by opaque bougie

Fig 203—Opaque bougie in ureter Portion of the stone has been chipped off by bougie and lies ¼ in above the main stone

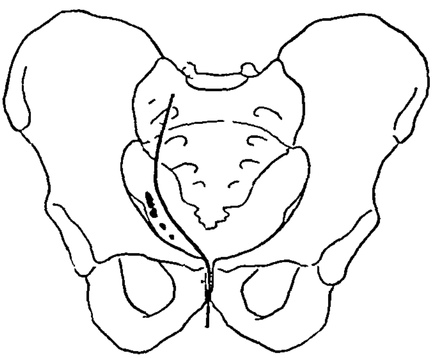


Fig 204—Calcified deposits in a seminal vesicle

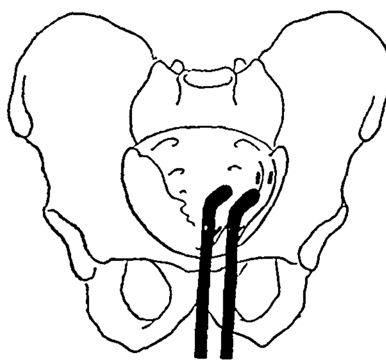


Fig 205—Two exposures on a single plate with different tube positions Relationship of shadow of the stone and the catheter is constant

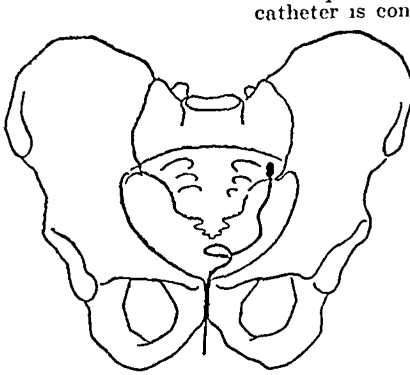


Fig 206—An obstructed catheter capped by a stone

IV UROGRAPHY

Ascending Urography—A shadow casting ureteric catheter is nowadays invariably preferred to a bougie so that advantage can be taken of its presence to fill the kidney pelvis with sodium iodide On radiographs it will show the extent of dilatation of the kidney pelvis and ureter (*Figs* 207 208 210) Even when the catheter cannot be passed beyond the stone the fluid will generally gravitate into the renal pelvis especially if the buttocks are raised It may

Fig 210 —Almond shaped stone just below the brim of the true pelvis Note the hydronephrosis and the hydro ureter and the hold up of the *contrast fluid by* the stone

also outline the contour of a stricture of the ureter *In this way* the degree of dilatation of the renal pelvis and ureter can be ascertained The onset of dilatation is important and should *not* be allowed to advance far without operative interference R H O B Robinson considers that retrograde pyelography should be used only if a catheter can be passed alongside the stone and up to the renal pelvis The contrast medium should be withdrawn after the picture has been taken and the pelvis washed out with saline The present writer removes the solution when possible but is not greatly disturbed if he cannot do so

Sometimes, when a stone shadow has not been seen on the first X-ray plate, the ureterogram will show an area of decreased density within the shadow of the filled ureter, indicating the presence of a stone transparent to the X rays The proximal ureter may be dilated Both these conditions are illustrated in *Fig* 208 Such stones are usually composed of pure uric acid, though occasionally they are of cystin Both these types are smooth and therefore pass out more

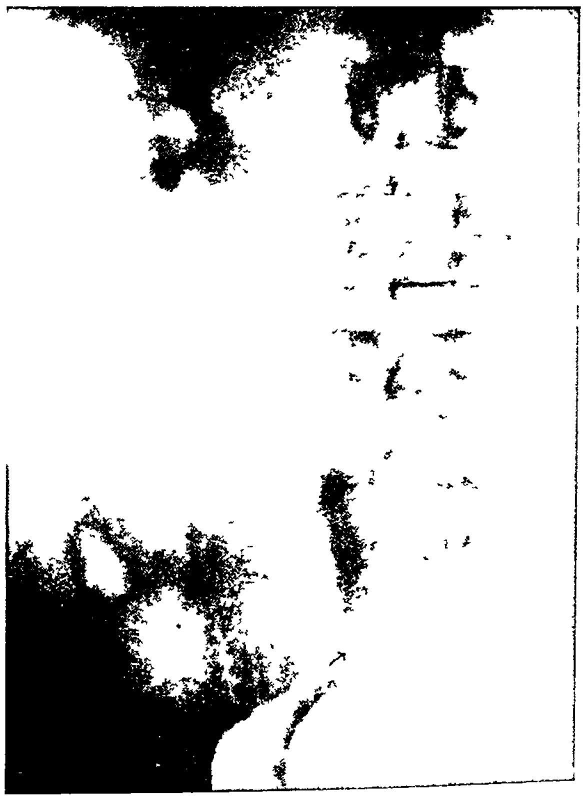


Fig 208 —Case of persistent right sided renal pain Straight X ray negative Carmine test showed delayed excretion on the right side Ureteric catheter refused to pass beyond sacro iliac joint Note the wide excursion of the catheter below and its immobility at the catheter tip, which suggests peri ureteric adhesions (cf mobility seen in many urograms, e g , *Figs* 263, 273, 310, etc) Filling defect just above catheter tip due to stone of poor radiological density Dilatation of the channels above this point

readily than the common spiculate oxalate stone Instances of transparent stones in the renal pelvis are not very uncommon

The ureter is a very mobile tube capable of a range of movement of $1\frac{1}{2}$ or perhaps 2 in on each side of its customary position Pressure on a ureteric catheter often displaces the ureter widely in the retro-peritoneal connective tissues, with the result that it may be seen over the spine internally, or well outside the psoas shadow externally

The deduction that peri-ureteral adhesions are present at the position of a stone can sometimes be made when a catheter tip meets a stone and the ureter proves to be unyielding at that site although below that point it has shown its customary mobility (see *Fig* 208)

Accentuation of the Stone Shadow—When a faint indeterminate radiographic shadow is seen in the line of the ureter it can be accentuated by the introduction around it of sodium iodide solution which adheres to and impregnates its surface and so accentuates its shadow. Before exposing the plates the excess of solution must of course be allowed to drain away. We owe the method to Kummel and it is valuable in selected cases. In such cases it appears probable that the stone is enveloped in a membrane which absorbs and retains some of the opaque solution

Excretion Urography (see Chapter XXVII) can play an important role in the diagnosis of ureteric calculi and is especially valuable when it is impossible to obtain an ascending ureterogram. Always given a sufficiency of excretory power on the part of the kidney descending urography will exhibit —

1 The coincidence of the ureteric shadow with that of the stone. The shadow of the ureter is generally sufficiently strong to convince especially when there is—

2 A hold-up of the contrast solution above the stone. If this feature is well developed the shadow of the reagent becomes richer and richer as time passes and more of the dye is secreted (cf *Fig* 33, A B page 519)

3 The degree of dilatation proximal to the calculus

4 By showing the line of the ureter and the absence of morbid change in that tube excretion urography will rule out extramural shadows that were regarded as possible stones

All these points are well shown in *Fig* 209

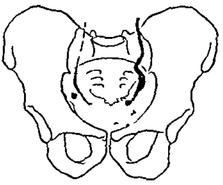


Fig 209—Stone in intramural part of left ureter. Tracing from an excretion urogram. See adjacent text and also contrast the ureteric shadow on the two sides

TREATMENT

A ureteral calculus may be treated expectantly by open operation or by cystoscopic manipulation. Many stones if left to themselves will descend the ureter without assistance (different writers estimate them between 50 and 95 per cent) and though this is a painful process some time should be allowed to elapse before active measures

Fig 212 —A, Twenty-two stones, each about the size of a large pea, packing the distal half of right ureter The renal outline is clearly seen (arrows) It is enlarged and immediately above it three stones lie in what is evidently the bottom of a thin-walled sac Right kidney not functioning, left kidney excreting satisfactorily Cystoscopic incision of ureteric lip Patient "woke at 3 15 a m to pass water but was unable to do so, at 5 a m passed 18 stones and it reminded him of machine gun firing At 6 15 a m he passed a further 6 stones and was then able to pass water" Six weeks later all the stones had passed except four, one being in the kidney and three in the ureter Two days later all four stones were in the kidney (B), illustrating capacity for retrograde movement in dilated passages Eventually all stones were passed

After this, some form of removal must be advised to save the kidney from the results of back-pressure and possible infection

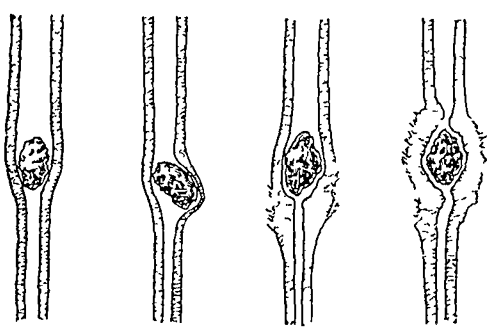


Fig 213 —Ureteric calculus A, Recent impaction, B, Older impaction, with some local thinning and bulging of the wall of the ureter, C, Old impaction—stricture below the stone, peri ureteritis and adhesion, D, Old impaction—additional stricture above the calculus In all cases there is dilatation of the proximal ureter

5 *The Position of the Stone.*—The higher the stone lies in the ureter, the more accessible it is to open operative treatment. A calculus at the ureteropelvic junction should be submitted to pyelotomy, as it is, for all intents and purposes, a renal stone I have on many occasions removed such a stone or one just below that point without mobilizing the kidney, which much reduces the severity of the operation But a stone lying at or anywhere above the pelvic brim is easily removed by operation and, in my

opinion should unless quite small be dealt with promptly before it passes over the brim for every further advance renders it more inaccessible to open methods and at the same time puts it in that section of the ureter where permanent impaction is most frequently observed To coax a calculus by transvesical manipulation down into that problematical zone the juxtavesical ureter seems to be taking an undesirable risk even though of course practically all such stones are eventually either passed or recovered by some surgical means If a stone when first seen has already reached this part of the ureter it is in the position where on the one hand, open operation is most difficult and on the other cystoscopic removal is most suitable and effective and the latter should therefore be given a trial in the first place Judd says that cystoscopic technique is here so successful that in the majority of cases of stones in the lower third of the ureter it must be considered the treatment of choice

6 *The Condition of the Kidney*—In old and advanced cases the kidney will often be reduced to a pyonephrotic sac as evidenced by pyuria fever a swelling in the loin the general urological investigation etc and on this or other account will require removal when the two conditions will undoubtedly be best treated simultaneously by open operation

7 *The Tolerance of the Patient to Cystoscopic Manipulation*—Though it is possible in some cases to obtain a successful result with a single cystoscopy several may be necessary and some patients are unsuited temperamentally to tolerate such interference

TECHNIQUE OF VARIOUS PROCEDURES

The following cystoscopic methods of treating ureteric calculi are available

1 Dilatation by ureteric catheterization
2 Injection of drugs through the catheter
3 Ureteric meatotomy
4 Dilatation by means of special instruments
5 Removal by traction

1 Dilatation by Ureteric Catheterization—As before stated the passage of a single bougie or catheter for diagnosis is often enough to dislodge a small or recently impacted stone and to cause its passage within a few hours or days Catheters may however be left in the ureter indefinitely Bugbee by catheterization alone claimed success in 326 patients out of a total of 347 and Crowell by this method combined with the injection of antispasmodics and analgesics through the catheter induced the descent in all but 7 of 140 consecutive cases Failure to make the catheter pass the stone is rare if the ureter is first anæsthetized with one of the derivatives of cocaine which

eliminates spasm and pain The catheter is left in situ for twenty-four or forty-eight hours, the urine passing through its lumen Generally twelve hours will suffice for the expulsion of the stone, which, however, may then cause considerable colic If the catheters remain in position for forty-eight hours or more, the descent is painless, or practically so The present tendency is to shorten the duration of catheterization to about five hours and to increase the period between treatments A catheter left in situ for some time may cause bleeding. Clots then block the lumen and there is ureteric obstruction and colic The catheter should be immediately removed for it is not feasible to syringe away the clots without further distending the pelvis and thus making matters worse

When the surgeon fails to get past the calculus, the catheter is allowed to remain with its tip in contact therewith After a day or so the obstacle can then usually be negotiated. Once beyond the calculus, an ascendancy has been gained over it which will probably end in its natural expulsion The stone is also sometimes, though less frequently, discharged, when the catheter has failed to get past it Whilst the catheter is in position the separated urine can be collected and examined and the kidney's function be estimated

If a small catheter has been employed to pass the stricture, it may be replaced periodically by larger ones until a No 11 Charrière is passed, the Joly or Buerger instrument being necessary to accommodate this size The ureter is a thin-walled tube and very distensible, it is more easily dilated than the urethra Crowell increases his dilatation until two No 11 catheters and one No 6 have simultaneously been inserted into the canal The No 6 is introduced through a No 15 child's catheterizing cystoscope in the male because the urethra will not admit two No 11 catheters and a single catheterizing instrument In the female, however, three or even more No 11's can be used The ureter can thus be greatly dilated The process is painless and after the first dilatation the patient often states that his discomfort has vanished A ureter thus widened will generally relax its grasp on the calculus especially if various supplementary remedies (*see below*) are employed to assist it The physical difficulties of introduction are however, not always easily overcome, and the friction of the catheters against each other may be considerable It is often impossible to pass the third or even the second instrument more than a few centimetres up the ureter Sometimes the stone has been pushed back into the renal pelvis by the catheters, but it quickly re-engages in the dilated channel on their removal and is generally evacuated The unusual combination of a ureteric stone and an ectopic bladder provided me with a unique opportunity for cystoscopic dilatation (*Fig* 214)

2 Injection of Drugs through the Catheter.—This method has been much employed and is often very effective. The value of cocaine derivatives to overcome spasm in the neighbourhood of the stone when passing the catheter has already been referred to. After having surmounted this obstacle drugs are still useful and fall into three categories:—

1. Those employed in quantity to irrigate the renal pelvis and help to mobilize the stone mechanically. They generally contain some antiseptic, as boric acid (sat. sol.) or flavine (1–1000 in aqueous solution). Oxycyanide of mercury (1–3000) and mercurochrome (1 per cent in normal saline) have also been recommended, but the writer has on more than one occasion seen severe albuminuria result from their use.

2. Those having a lubricating action, of which paroleine (pure liquid paraffin), olive oil, and glycerin are the most used.

3. Drugs having an antispasmodic and anodyne action. Papaverine sulphate (4 per cent) had a vogue at first, but novocain (4 per cent) or procain (novocain Metz) (5 per cent) are now held to be the most serviceable. They control pain, and overcome spasm, which is important in encouraging the extrusion of the calculus.

Fig. 14.—Stone in the ureter of a patient with ectopia vesicæ. Characteristic deformity of the bony pelvis. Dilatation of the ureter facilitated by the exposed position of the meatus.

I find that a calculus rarely moves so long as the catheter is in situ. Before withdrawal the ureter should be re-anæsthetized and the pelvis distended with fluid in order to propel the stone along the canal. If sterile olive oil or paroleine is used for this purpose its lubricating qualities will be valuable, whilst its viscosity will mechanically aid the progress of the calculus.

It is found in practice that there is difficulty in maintaining *perfect* asepsis of the external end of a ureteric catheter which has been in situ for long. Should any doubt exist as to its sterility, intra-ureteric medication must not be risked. I regard this as a principle the importance of which can scarcely be overstated, but to which sufficient attention is not paid.

liberate a stone in the lowest section of the canal or as a preliminary to instrumentation of the more distant ureter. This is the narrowest portion of the whole tube, being about $\frac{1}{10}$ in. broad as contrasted with the central portion, which is about $\frac{1}{4}$ in. and the renal outlet which has a diameter of $\frac{1}{7}$ in. (Sinclair White). Jeanbrau in 204 cases found 51 per cent of stones in the pelvic ureter, whilst Bugbee found 86 out of 107 ureteral calculi in the lowest twelve centimetres and 65 in the lowest six centimetres He states that few pass through the lowest three centimetres of the ureter without becoming impacted at least temporarily. Braasch and Moore have shown that stones arrested in the ureter do not lie immediately above the narrow section, but a short distance away. A fact which is not always realized is the relative rigidity of the bladder wall surrounding the intramural ureter, which contrasts strongly with the easy dilatability of the rest of the channel, and, additional to the narrowness of the tube, is a factor in arresting calculi. This unyielding section appears first of all to forbid the entrance of the stone and subsequently to grip it tenaciously.

The scissors, similar in construction to Buerger's forceps (*Fig* 138, page 232), are passed through one of the more capacious cystoscopes—Swift Joly or Buerger. One blade is introduced into the ostium and the upper wall of the latter is slit up to an extent which appears through the cystoscope to be about one inch in length. It may be difficult to insert the blade if the stone is very close to the orifice In practice these scissors prove to be fragile and the first or second incision is likely to be inadequate. Hæmorrhage then clouds the field and hinders further progress It is occasionally very severe and distension of the bladder with clots is not unknown

Diathermy, or better, endothermy (*Fig* 215) of the anterior wall of the intravesical ureter is easy, and the extent of the incision is

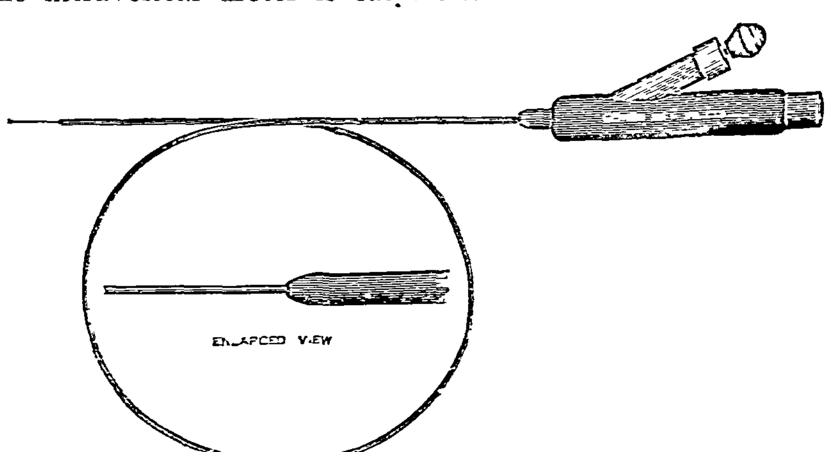


Fig. 215—Electro surgical meatotome with fine platinum cutting point which can be withdrawn into the insulating sheath

under more accurate control than is the case when cold cutting instruments are employed. As hæmorrhage is absent the operation can be performed deliberately. When the stone actually presents at the opening (*Plate XIII C*, page 338, and *Fig* 216) or when it is lodged immediately above, as evidenced by an oval swelling on the course of the ureter, the electrode may be employed directly over it. When it is an inch or so higher and the incision is a preliminary to subsequent instrumentation, a bougie should first be passed into the ureter in order to make a rigid salient against which the electrode can be applied and to guard the lower wall of the canal from injury. If diathermy is used a week or more is required for the separation of sloughs, so that the stone is not so immediately liberated as when the cutting current or scissors are employed. For this reason, when dealing with urgent cases, especially with calculous anuria, diathermy is inferior to the cutting current or scissors.

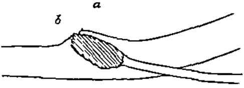


Fig 216.—Sites for application of electrode when a stone impacted at the meatus is being released by diathermy. *a is the usual and more important position*

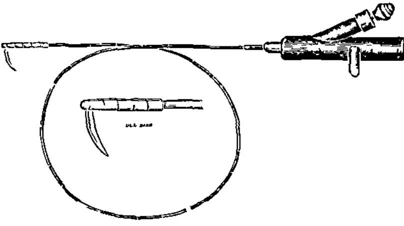


Fig 217.—Ogier Ward's ureteral meatotome

Ogier Ward has devised a ureteral meatotome (*Fig* 217) in which *an electrical knife shaped something like a rhinoceros's horn* is concealed. The instrument is introduced into the ureter to the requisite distance and the blade is made to transfix the ureteric cusp. The endothermy current is now turned on and the meatotome is withdrawn, leaving the cusp divided and coagulated.

It has been said that incision of the ureteric meatus is likely to lead to permanent regurgitation up the ureter with resulting hydroureter and back pressure on the kidney. The present writer has cut many ureteric lips without observing this sequel. The question was

investigated experimentally in dogs by Draper and Braasch They cut one ureterovesical valve, leaving the other intact At the end of a period varying from 5 to 23 weeks they found a hydro-ureter on the operated side in one case only, and concluded that the operation of meatotomy is without danger in the human Gruber has repeated these experiments He found that after *full* excision of the ureteric flap regurgitation into the ureter was invariable and that manometric pressures in the ureter approximated to those in the bladder Dilatation of the ureter followed If, however one-third to one-quarter of the ureteric valve remains this "does not necessarily incapacitate the valve to low or even normal intravesical pressures. With the aid of the intramural ureter, the oblique passage of the ureter through the thick bladder wall in human beings, the ureterovesical valve remaining after meatotomy would probably maintain its competency

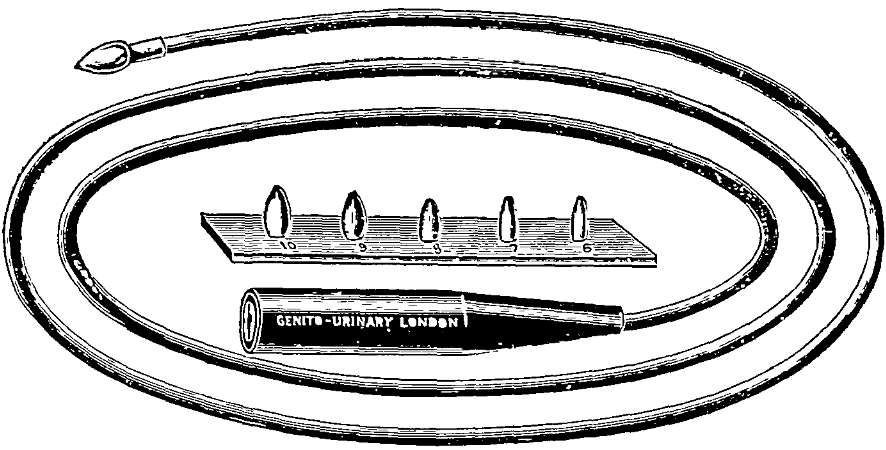


Fig 218—Buerger s dilating olives

No one seems to have reported the development of a hydro-ureter or a hydronephrosis following meatotomy for the removal of stones in the ureter ". Gruber suggests that the disagreement between his own results and those of Draper and Braasch are accounted for by the latter authors not having completely divided the ureteric valve

4. Dilatation by Means of Special Instruments.—Historically this is the first group, for Simon, of Heidelberg in 1865 suggested ureteric dilatation, and Nitze (1907) invented a ureteric catheter having near its tip a membranous balloon capable of an distension through the lumen of the catheter He really designed this instrument with the purpose of occluding a ureter so that he could collect the unmixed urine from the opposite kidney Jahr almost immediately seized on the device to dilate the ureter in a case of calculous anuria and met with success

Buerger has introduced graduated metal olives for dilatation of the ureter (*Fig* 218). They vary from 6 F to 20 F in size, and

are used with the operating cystoscope They screw on to the end of a No 9 F silk ureteral catheter which serves as insulation for a wire cable the proximal end of which carries a coupling for connection to the diathermy machine The largest olive is flattened to permit its exit through the fenestra of the cystoscope The bipolar diathermy current in small doses has the effect of relaxing smooth muscle, and therefore dilates such a tube as the ureter A small olive is first employed It is passed up the ureter until held up when 300 to 400 milliamperes are brought into action gentle pressure being maintained against the obstacle When this yields, the process is repeated with successive sizes of olives In many cases the stone is expelled in a few days The procedure is not without danger and the utmost care must be exercised in the use of diathermy as too strong a current will give a ureteral burn which may lead to perforation or a stricture

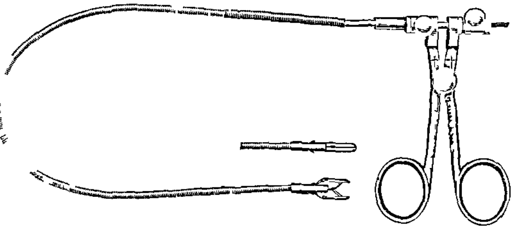


Fig 219 —Bransford Lewis s ureteral dilator

Bransford Lewis has made a neat little dilator (*Fig* 219) similar in principle to the straight Kollmann s urethral dilator and manipulated from the exterior by a cable It is specially useful in the intramural ureter but is also employed at greater heights —4 or 5 in — whilst Crowell has used it up to the renal pelvis The writer would hesitate to employ it except in the last inch and a half of the duct By it dilatation can be effected up to 24 Charriere It is a very serviceable instrument

Laminaria tents oval in shape 1 in long and No 10 F in size and having a central bore for the passage of urine from the kidney have been employed by Canny Ryall in the lowest inch of the ureter and have been left in situ by him for twenty four hours

Dourmashkin believes that dilatation of the ureter at and below the stricture is the procedure of choice He is opposed to the use of

traction (*see later*), but employs greater degrees of dilatation than most workers which he does not hesitate to make use of right to the pelvi-ureteric junction. In the upper 20 cm of the ureter, and even for stones in the renal pelvis, dilatation is achieved by means of a rubber balloon (1926) attached to a ureteric catheter, which will, if necessary, give dilatation up to 24 F, but in the lower 5 or 6 cm of the ureter "and especially in its intramural portion, because considerable force is required to stretch the latter's strong muscular wall", it is carried out by tunnelled metallic dilators (*Fig* 220) These dilate to a maximum of 20 F The dilatation must include the section of the ureter in which the stone is lodged and for this reason the stone is, if possible, pushed into the dilated portion above If it is not possible to dislodge the stone the dilatation must be confined to the area below the

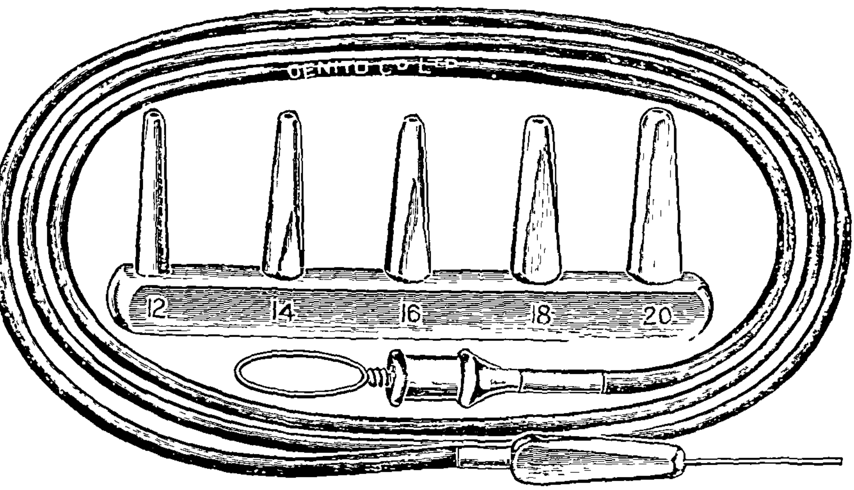


Fig 220 —Dourmashkin's ureteral dilators

calculus—the instrument being "crowded" to the stone as much as possible—which in practice frequently proves to be effective Dourmashkin says that "the entire dilatation may be carried out in one sitting, beginning with No 12 F bougie and ending with No 20 F"

5. Instruments designed to put Traction on the Stone.—The use of catheters to dilate the ureter has already been described Alyea (1938) and others have recommended that multiple catheters (2 to 5), or two catheters and as many bougies as possible be introduced The instruments are rotated on their long axes, individually and collectively, either immediately or within an hour or two The intra-ureteric loops thus formed may enmesh the stone, and it can then be pulled upon

McKay (1930) devised a whalebone bougie—subsequently modified by Moore (1937)—to which silk threads are attached This is

passed beyond the calculus and when traction is made on the threads the bougie is bowed and the stone is caught amongst the threads

Another instrument of similar idea is that of Zeiss (1937) who produced a loop on a catheter by fastening a silkworm gut suture to the catheter tip The suture entered the lumen of the catheter a short distance below the tip and when traction was exerted on the gut a loop was produced The catheter tip is introduced into the

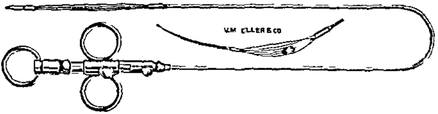


Fig 221—The Councill stone dislodger

ureter above the stone and this segment being dilated it will accommodate the catheter during the formation of the loop

The Councill (1936) stone dislodger or basket (*Fig* 221) has a control wire like that used in the Bransford Lewis dilator (*Fig* 219) The wire operates a wire mesh or basket which when expanded both dilates the ureter and enmeshes the stone Ferguson Bohringer and Johnson have designed similar instruments Ferguson has said that

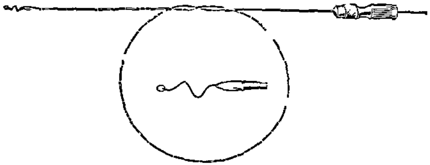


Fig 222—The Howard extractor

intermittent traction under sedation may be maintained for up to 2 hours by means of a rubber band attached to the knee This advice does not commend itself to the present writer

The Howard extractor (1928) is a spiral or corkscrew wire with an olivary point (*Fig* 222) A screw like motion is imparted to it as it ascends the ureter and the stone gets caught in the corkscrew coils so that traction can be brought to bear on it If the stone refuses to move a reversal of the screwing motion will liberate the instrument

Buerger's forceps are shown in *Fig* 138, page 232 By them a stone can sometimes be extracted from the ureteric orifice after incision, and then withdrawn from the bladder However, if left to itself the stone shortly falls free into the vesical cavity and is evacuated naturally

Most of these instruments suffer from an obvious objection The ureter at the site of the stone and probably above that point is dilated to the dimensions of the stone Below that point no dilatation has as yet occurred and in many cases there will be considerable discrepancy between the size of the ureter and that of the stone Councill recognizes this and writes, "No stone should be extracted until the tract below the stone has been thoroughly dilated The size of the tract below the stone not the size of the stone is the index for extraction"

It does not take much imagination to realize that injury to the ureter is not unlikely and that there is always a chance that the instrument will get broken or become impacted in the ureter, and, in fact a number of accidents during the forcible extraction of stones have been reported In some cases parts of the instrument have broken off or portions of stone baskets have perforated the walls of the ureter In others the mucosa of the ureter has been torn either by a spiculated stone or by the instrument employed, or the whole thickness of ureteric wall has given way causing urinary extravasation into the peri-ureteric tissues Nevertheless it must be recorded that many series of highly successful manipulations have been published by the advocates of these methods But whenever using any of these mechanical devices in the ureter the operator must ask himself whether he is satisfied that they will be safely and easily withdrawn

Watching for the Stone.—After any kind of ureteral manipulation, unless the stone has actually come away the patient must keep a look-out for it, otherwise a small stone may escape unnoticed This is more likely to happen with a woman than with a man Each sex should use a receptacle which can be easily examined For men the best plan is to cover a conical specimen glass with butter muslin and to urinate through that

CALCULOUS ANURIA

Albarran in 1901 originally suggested ureteric catheterization as a method of relief for calculous anuria but Cimino in 1903 was the first to put it into practice successfully

Diagnosis.—When confronted with a case of anuria it is first of all necessary to satisfy oneself that the anuria results from a ureteric stone, and then to determine the respective part played by each kidney The diagnosis and treatment should be undertaken promptly for though several days may elapse during which the patient appears

to suffer no inconvenience from the absence of his urinary secretion (period of tolerance) it has been shown by Huck that the operative mortality increases steadily with each day that is lost.

The diagnosis is made by symptomatology, by X rays, and by the cystoscope. In the commonest class of case where one kidney is destroyed by old-standing calculous disease, a lengthy history of unilateral renal ache, extending back over a number of years, can usually be elicited, and in addition to this there is a recent history of a sudden attack of pain on the opposite side. This latter, however, is by no means constant, as the recently plugged ureter may be silent or the pain so slight as not to excite comment apart from direct inquiry. The X rays and excretion urography should be employed at the earliest possible moment, and will generally show extensive calculous destruction of one kidney, and a shadow, usually small, in the opposite pelvis or ureter, whilst meatoscopy may reveal some of those changes already described as characterizing the presence of a stone freshly impacted in the ureter—ecchymoses, œdema, hæmaturia, etc. Where one ureter is plugged by a stone and the opposite kidney is congenitally absent the corresponding meatus may also be missing (*see* page 397).

Object of the Catheterization.—The side to which catheterization must be applied is that one containing the newly impacted stone, as shown by the recent pain, by radiography, and by the cystoscopic picture. It is hoped that the tip of the instrument will negotiate the stone, and thus be able to drain the renal pelvis. If this is successful the anuria is immediately relieved. In some cases, however, it is impossible to get beyond the obstruction, but even so the stone may be displaced by the catheter and relief may thus be obtained, or the injection of paroleine may mobilize it, whilst novocain injected around it may overcome the ureteric spasm.

If the ureteric catheter reaches the kidney it may tap a distended cavity, but quite frequently it finds the pelvis empty. In the former case there is an immediate flow of urine from the catheter, but in either case as soon as the obstruction is relieved the kidney starts to secrete urine, and in a very short time a profuse polyuria occurs. It is wise to aid this polyuria by copious draughts of water or by intravenous salines.

Having obtained relief from the anuria it must be decided how long the catheter shall be left in the ureter. By leaving it in situ for some time we guard against the danger of an early recurrence of the suppression, an occurrence which has been found very prone to take place when the catheter is removed. Moreover, if it remains in the ureter it will dilate that channel, thus preparing the way for the spontaneous evacuation of the stone. The rules already laid down

Ulceration is rare, except in tuberculous disease (*see* Chapter VII)

Epithelial Proliferation —In long-standing chronic cases heaped-up masses of pale epithelium are occasionally seen on the margin of, and around, the orifice (*Plate XIV* C) In acute cases the red œdematous mucosa may encroach on the meatus, but this is rather a result of the associated cystitis than a ureteric change

Miscellaneous Changes at the Ureteric Orifice.—

Ureteric Catheterization —For several days after this procedure the meatus is slightly hyperæmic and swollen Sometimes a few ecchymoses may also be seen It soon reverts to the normal condition, however, but should the catheter have been long in position the changes are more pronounced and subside more slowly

Operation —After incision of the upper ureteral wall with scissors or diathermy some permanent deformity invariably remains, there often being some loss of tissue Generally a gutter-shaped orifice with irregular margins results, the ureter debouching higher than usual When a ureter has been resected and reimplanted in the bladder, it occupies an abnormal situation It then appears as a pinkish, rigid orifice of small size and circular shape, and is surrounded by a paler area consisting of scar tissue

Dilatation of the Orifice —This occurs in cases where there has been back-pressure from prostatic hypertrophy or stricture but in my experience it is often absent, and is generally not very obvious through the cystoscope, even when the valve mechanism is clinically incompetent and allows regurgitation of urine up the ureter After the removal of the sac of a ureterocele by open operation or by diathermy the resulting orifice is patulous and the ureter and pelvis are dilated When a tuberculous ureter has healed following nephrectomy it may remain gaping and rigid

Tumours —Growths arise frequently on the edge of the ureter. If of any size they may cover the opening (*Fig* 109, page 189) *Plate VII* E, page 172 shows a papilloma which actually originated in the ureter and mushroomed into the bladder cavity Though not very common, such an occurrence is well known The growth may be primary in the ureter itself or an implantation from a similar papilloma of the renal pelvis (*see also* pages 192 and 469)

II. CHANGES IN THE EFFLUX

Alterations from the normal in the frequency and copiousness of the efflux are not very easy to estimate, and do not generally give much information, because the normal speed and character are themselves so variable In the ordinary way a movement occurs once in every ten or twenty seconds, but quite often one may watch an orifice for several minutes without noting any such movement Nor is

it always possible to be certain when a contraction does occur that there is an emission of urine for unless the swirl is fairly vigorous it does not become visible The kidney appears to have periods of rest from excretion during which the ureter does not receive the reflex stimulus to contract If however it is stimulated by a copious draught of water it will when healthy start to throw out this extra fluid within five or ten minutes The stimulus of urea or a dye introduced into the circulation has similarly the power to awaken the activity of the kidney

Absence of Contraction —If under prolonged inspection or under such artificial stimulation as I have mentioned no contraction is observed some explanation must be sought The following possibilities must be considered —

1 The kidney may be congenitally absent or atrophic

2 It may have been completely destroyed by disease

3 The urine may be retained in a hydronephrosis or be dammed back by a stone impacted in the ureter

4 The urine may be drained away by a ureteric fistula Usually with a ureteric fistula as also with a stone in the ureter the peristaltic movement is propagated to the bladder and is visible there though generally enfeebled and infrequent

The absence of a satisfactory efflux should be confirmed by chromocystoscopy

Increased Contraction —Increase in the force and frequency of the contraction may be present —

1 In the normal kidney during a period of special activity such as occasionally occurs to counterbalance the period of inactivity above described

2 In compensatory hypertrophy of one kidney when the other is absent diseased or destroyed

3 In polyuria from whatever cause—forced diuresis high blood pressure interstitial nephritis glycosuria etc

4 When the kidney or ureter is irritated by the presence of a stone or from other irritating disease—the early stage of tuberculosis of the kidney for instance

Hæmorrhage —Bleeding from the kidney may be slight or copious Its recognition at the ureteric meatus is valuable information in the localization of disease

Slight Hæmorrhage —Hæmorrhage may be so slight that it cannot be detected cystoscopically though even when inconsiderable it is often apparent In doubtful cases ureteric catheterization does not help much for traumatic hæmorrhage resulting from the passage of the catheter cannot be distinguished from that caused by renal disease In these obscure cases the site of origin of the hæmaturia

may be revealed by some other form of examination, of which X rays, renal function tests, and pyelography are the most likely to assist. Sometimes these cases are very difficult and disquieting. When the diagnosis is obscure it is better to await further developments than to operate or even express an opinion on insufficient evidence.

Not infrequently the question arises whether a hæmorrhage is unilateral or bilateral. In some such instances it may be possible to say that there is blood coming from one meatus, whilst it is impossible to be sure that it is absent from the other. This difficulty arises only when the hæmorrhage is small in amount. When copious and of the surgical type it is usually unilateral.

Copious Hæmorrhage.—Copious hæmorrhage from the upper tract is generally easy to detect if still active, but it should never be assumed that it will continue, and its investigation should be undertaken promptly (*see* Chapter XI). It may occur:—

1. In the form of a bright-red efflux, the colour varying in intensity with the severity of the bleeding. Frequently, however, the

PLATE XIV

A, Worm-like clot of blood partially extruded from ureter. B, Lava-like stream of pus from right ureter flowing slowly into the retrotrigonal recess. C, Ureter in chronic pyelitis. Heaped-up masses of thickened epithelium are seen around the ureter and below it. D, Copious efflux of indigo carmine from left ureter. Note the slight blue haze in the bladder medium above and to the left of the ureter. E, Double ureter (left side). The lower ureter is on the outer aspect of the ureteric bar. F, The same after catheterization. The modification in the position of the orifices is due to the drag of the catheters.

efflux has a somewhat brownish tinge, owing to changes produced by contact with the urine.

2. When the blood has been retained for a time in the renal pelvis, either through clotting in a normal pelvis, or especially when due to hæmorrhage into a hydronephrosis, it may come away in small shreddy clots of brownish-red colour.

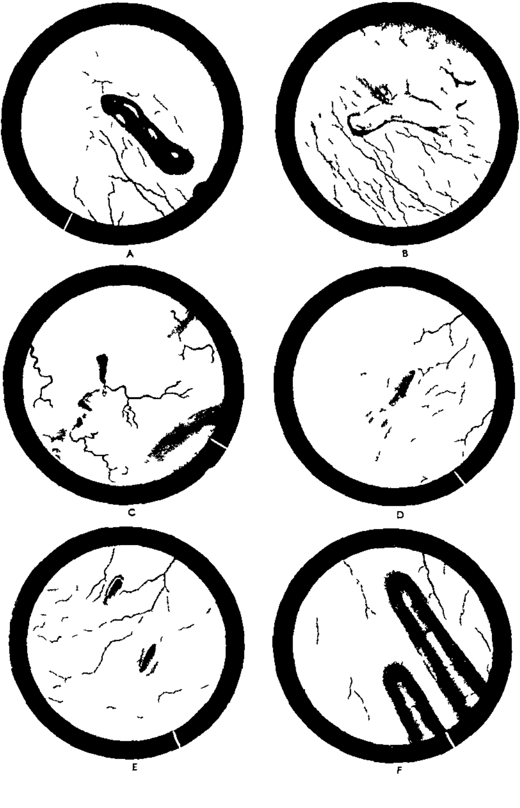
3. Clotting may take place in the ureter, producing the worm-like coagula sometimes found in the urine. Such a clot is occasionally seen in process of being extruded from the ureteric meatus (*Plate XIV* A). It is a deep purplish-red comma-shaped or club-shaped body hanging from the orifice, but if its expulsion is delayed it becomes decolorized and is then greyish in colour and appears granular and laminated in texture.

Pus.—Pus escaping from the ureteric meatus may be small in quantity or plentiful. It is less evident, quantity for quantity, than blood, owing to the difference in colour.

Small Amounts.—When finely particulate, for instance in *B. coli* infection of the kidney, there is *generally not* sufficient pus to be

PLATE XII

THE URETER IN VARIOUS CONDITIONS



obvious through the cystoscope When the origin of pus is being investigated a careful scrutiny of the meatus should nevertheless be made and with the objective close to the orifice a hazy efflux or actual pus flakes may be observed Purulent debris is almost invariably present, in greater or less degree on the bladder wall in these cases and the cystoscopist should always be on his guard to avoid mistaking the movement of particles of debris disturbed by the ureteric efflux for the actual emission of pus When in doubt catheterization of the ureter will collect infected urine from the kidney and the presence of pus and organisms can be demonstrated pathologically

Moderate Amounts—When it is more plentiful pus renders the ureteric efflux definitely turbid The muddy urine diffuses itself in the medium and temporarily renders it hazy Marion has compared the effect to that of a snowstorm The speed with which the medium clears again depends on the consistency of the pus When finely divided it remains suspended for a time in the vesical fluid Larger flocculi more quickly settle to the bladder base whilst inspissated matter never rises off the vesical floor but rolls along it lazily like a stream of lava

Kidneys producing pus in small or moderate amounts are often valuable organs playing a varying but generally considerable part in the excretory functions of the organism They are usually not suitable objects for surgical activity the more so as this type of infection is frequently bilateral They often produce a normal or even more than normal quantity of urine though this may be deficient in solids and the function of the organ actually reduced

Copious Pus—When pus originates in a pyonephrosis it constitutes a large proportion of the ureteric effluent indeed there may be little urine or none at all mixed with it The consistency of the efflux will vary according to the proportions of these two fluids Often it is grey grumous and almost jelly like at other times it is creamy and semi solid and then contains practically no urine Even from a pyonephrosis it occasionally issues with fair force into the vesical cavity but on other occasions it trickles feebly over the margin of the meatus and rolls away in a worm like stream to the bladder sump This appearance has been aptly compared to that of paint expressed from a squeezer tube (*Plate XII* B)

In these advanced cases the emission of the pus is not continuous Long intervals may occur between the delivery of two separate amounts into the bladder I have watched the ureter mouth for as long as fifteen minutes in suspected cases to be rewarded ultimately by seeing the creamy fluid emerge therefrom If the cystoscopy is hurried in such circumstances the picture may be missed Gentle bimanual pressure over the affected kidney has often in my experience

been very effective in dislodging the purulent contents of the pelvis and accelerating their appearance in the bladder A kidney in this condition is valueless and probably takes no part in the excretory work of the body

URETERIC CATHETERIZATION IN DIAGNOSIS OF RENAL DISEASE

The indications for ureteric catheterization are (1) *In order to search for the primary seat of disease*, (2) *To test the function of the remaining kidney* (3) *As a preliminary to urography*

1. Search for the Primary Seat of Disease.—The search for the primary seat of disease in the upper urinary tract has in most cases been successful before the stage of ureteric catheterization arrives, but if it has hitherto evaded discovery, it will fall to the lot of the ureteric catheter to trace it This it will do in two ways (*a*) By showing a kidney with a damaged function, and (*b*) By collecting urine containing pathological material The examination under these circumstances must be a bilateral one and, if the disease is one-sided, the urine from the second kidney will indicate the function of that gland

2. Testing the Function of the Remaining Kidney.—When the site of the disease has been settled earlier in the investigation, probably all that remains is to decide the function of the remaining kidney This may be done by urography, by chromocystoscopy, or by ureteric catheterization If the last mentioned is chosen, only one side need be catheterized, the other kidney being known to be diseased, though some surgeons prefer bilateral catheterization even in these circumstances

Relative Advantages of Ureteric Catheterization and Chromocystoscopy —Ureteric catheterization presents certain disadvantages and also certain advantages in renal function testing as compared with chromocystoscopy

Disadvantages —It is admitted that in some instances catheterization of the ureter has an inhibitory effect on renal activity. When this happens it may lead to an erroneous impression of a kidney's efficiency It is generally of short duration, but even so may outlast the stay of the catheter in the ureter Chromocystoscopy evades this disadvantage

The catheter may occasionally fail to collect the urine from the kidney owing to its becoming blocked or to the urine escaping alongside the catheter This is more likely to happen with small catheters than with larger ones Blocking of the catheter is obviated by injecting through its lumen a drachm or so of sterile water after the instrument is in situ The addition of even this amount of fluid

to the renal secretions proper may make an appreciable difference to function tests in view of the small quantities usually collected Urine escaping alongside the catheter finds its way into the bladder Its recovery from that viscus either by simultaneous vesical catheterization or by normal micturition immediately after the ureteral instruments have been removed will show the quantity of fluid thus lost but it will not tell from which kidney it has come This, together with the undesirability of keeping catheters in the ureters for any length of time is the reason why many surgeons have now discarded the attempt to estimate separate renal excretion *quantitatively* there being obviously a large and incalculable error from this cause

Many renal functional investigations are performed on out patients I avoid as far as possible catheterization of the ureters of those who have to travel and who may thus be exposed to chill Chromocystoscopy is peculiarly suitable for this class of work owing to its simplicity quickness and avoidance of ureteric catheterization

Advantages —The signal advantage of ureteric catheterization is that in addition to providing data for renal function estimations it supplies material for pathological investigation which throws more light on the condition of the kidney than can be obtained by simply observing its dye excreting capacity It is therefore the more searching test Where however the surgeon is satisfied as to the freedom from serious disease of this second organ the ease of application of the carmine test will lead to its selection

PATHOLOGICAL EXAMINATION OF SPECIMENS COLLECTED BY URETERIC CATHETERIZATION —The urine sent to the laboratory is accompanied by a request for its chemical microscopical and bacteriological investigation It is not proposed to enter fully into such reports which do not strictly come within the scope of cystoscopy The reports must be exhaustive and when available will be correlated by the surgeon with other facts already in his possession They need however interpretation with a knowledge of certain fallacies —

a Ureteric catheterization is frequently almost invariably accompanied by some hæmorrhage which may be macroscopic or microscopic and is due to friction occurring between the catheter and the wall of the ureter or to bruising of a renal papilla It is always remarked in the pathologist s report As has been observed already this traumatic blood cannot be differentiated from blood of pathological significance and it unfortunately renders the ureteric catheter valueless in the localization of renal hæmorrhage

b The serum albumin of the blood is indistinguishable from other albumin of renal origin If the traumatic bleeding of catheterization is copious the resulting albumin may also be considerable when however the bleeding is slight the albumin may be negligible

In considering small quantities of albumin occurring in ureteric catheter specimens, the possibility of its having this origin must be taken into account

The difficulty is best illustrated in connection with the presumed healthy kidney in *serious* unilateral renal disease In such disease it is well known that a low-grade inflammatory change occurs in the neighbouring gland, determining albuminuria therefrom This change, which is most characteristically seen in renal stone and tuberculosis (though also in other diseases), is at first a subacute parenchymatous nephritis, whilst later there occurs in many instances an actual extension of the original disease to the second organ The importance of disease in this second kidney does not require emphasis, especially when nephrectomy is contemplated It is generally easy to discover the propagation of the original disease to the neighbouring gland—in the case of lithiasis by X rays, and in the case of tuberculosis by ureteric catheterization—but sympathetic nephritis is a phenomenon for which one must watch, particularly in these two diseases It is not easy to detect Its effects are not separately discernible in the general health of the patient The resulting albuminuria is slight in quantity and is quite obscured by pyuria and albuminuria from other sources whilst ureteric catheterization is subject to the fallacy that traumatic blood may be present in sufficient quantity to complicate the interpretation It will thus be seen that the presence of a slight albuminuria from the second kidney in these cases of primary unilateral renal disease is difficult to detect, even though important It should be said, however, that this sympathetic nephritis, which may also determine the presence of casts in the catheter specimen, is kept up by the irritation and toxæmia arising from its diseased neighbour, and after removal of the latter it tends as a rule to subside, the function of the gland simultaneously improving

3 **Urography** (*See also* Chapter XXV) —In renal function testing we have a means of showing the physiological state of the kidney, in pyelography a method of demonstrating its anatomical condition The former will tell that a kidney is wholly or in part disabled but may fail to say why. The latter not infrequently makes good this omission The two examinations are related and complementary, and their results must be reviewed together Instrumental pyelography may be undertaken as a separate examination, or the pyelographic medium may be introduced into the kidney as soon as the separated urines have been obtained and the function tests completed When feasible the latter is the better way, as it avoids a second cystoscopy and ureteric catheterization.

CHAPTER XXIII

CONGENITAL ABNORMALITIES OF THE KIDNEY AND URETER

MALFORMATIONS of the upper urinary tract are constantly cropping up. Probably no other visceral system is so frequently misformed or presents such a variety of deformities. All these abnormalities are of first rate importance to the surgeon and of great academic interest. Modern methods show them to be far from uncommon and it is evident that they have in the past been overlooked. They can be recognized and correctly diagnosed by cystoscopy and urography, and the large number of cases appearing in the literature in recent years suggests that excretion urography is bringing many to light which would otherwise have remained unsuspected. But if the surgeon is unfamiliar with their embryology, variety and their radiographic appearances, he must of necessity meet with surgical puzzles which are easily solved if the requisite knowledge is forthcoming but are insoluble in its absence. All the congenital abnormalities of the urinary apparatus predispose to disease, and therefore appear in any urological department with a frequency quite disproportionate to their incidence in the general population. Congenital abnormality is important rather by reason of its complications than on its own account, and where it is encountered care should be taken to exclude disease in all component parts of the upper urinary tract. A study of the pyelographic picture will play an important part in this exclusion. The following pages find a fitting inclusion in this book because, without a knowledge of the mechanism of production of these deformities and of the cystoscopic and urographic pictures which result from them, correct interpretation is impossible.

The congenital abnormalities of the upper urinary tract will be considered under the following heads:—

I. MALFORMATIONS OF THE KIDNEY—

1. Fused kidney.
   - *a*. Central: Discoid; Shield; Horseshoe.
   - *b*. Unilateral crossed ectopia: S-shaped or sigmoid kidney; Long or long simple kidney.
2. Ectopic kidney.
3. Congenitally underdeveloped kidneys: Hypoplasia; Aplasia; Agenesis—solitary kidney.
4. Absence of both kidneys.
5. Supernumerary kidney.

In considering small quantities of albumin occurring in ureteric catheter specimens, the possibility of its having this origin must be taken into account

The difficulty is best illustrated in connection with the presumed healthy kidney in *serious* unilateral renal disease In such disease it is well known that a low-grade inflammatory change occurs in the neighbouring gland, determining albuminuria therefrom This change, which is most characteristically seen in renal stone and tuberculosis (though also in other diseases), is at first a subacute parenchymatous nephritis, whilst later there occurs in many instances an actual extension of the original disease to the second organ The importance of disease in this second kidney does not require emphasis, especially when nephrectomy is contemplated It is generally easy to discover the propagation of the original disease to the neighbouring gland—in the case of lithiasis by X rays, and in the case of tuberculosis by ureteric catheterization—but sympathetic nephritis is a phenomenon for which one must watch, particularly in these two diseases It is not easy to detect Its effects are not separately discernible in the general health of the patient The resulting albuminuria is slight in quantity and is quite obscured by pyuria and albuminuria from other sources, whilst ureteric catheterization is subject to the fallacy that traumatic blood may be present in sufficient quantity to complicate the interpretation It will thus be seen that the presence of a slight albuminuria from the second kidney in these cases of primary unilateral renal disease is difficult to detect, even though important It should be said, however, that this sympathetic nephritis, which may also determine the presence of casts in the catheter specimen, is kept up by the irritation and toxæmia arising from its diseased neighbour, and after removal of the latter it tends as a rule to subside, the function of the gland simultaneously improving

3 **Urography** (*See also* Chapter XXV) —In renal function testing we have a means of showing the physiological state of the kidney, in pyelography a method of demonstrating its anatomical condition The former will tell that a kidney is wholly or in part disabled but may fail to say why. The latter not infrequently makes good this omission The two examinations are related and complementary, and their results must be reviewed together Instrumental pyelography may be undertaken as a separate examination, or the pyelographic medium may be introduced into the kidney as soon as the separated urines have been obtained and the function tests completed When feasible the latter is the better way, as it avoids a second cystoscopy and ureteric catheterization.

CHAPTER XXIII

CONGENITAL ABNORMALITIES OF THE KIDNEY AND URETER

MALFORMATIONS of the upper urinary tract are constantly cropping up. Probably no other visceral system is so frequently misformed or presents such a variety of deformities. All these abnormalities are of first rate importance to the surgeon and of great academic interest. Modern methods show them to be far from uncommon, and it is evident that they have in the past been overlooked. They can be recognized and correctly diagnosed by cystoscopy and urography, and the large number of cases appearing in the literature in recent years suggests that excretion urography is bringing many to light which would otherwise have remained unsuspected. But if the surgeon is unfamiliar with their embryology, variety and their radiographic appearances, he must of necessity meet with surgical puzzles which are easily solved if the requisite knowledge is forthcoming but are insoluble in its absence. All the congenital abnormalities of the urinary apparatus predispose to disease and therefore appear in any urological department with a frequency quite disproportionate to their incidence in the general population. Congenital abnormality is important rather by reason of its complications than on its own account, and where it is encountered care should be taken to exclude disease in all component parts of the upper urinary tract. A study of the pyelographic picture will play an important part in this exclusion. The following pages find a fitting inclusion in this book because without a knowledge of the mechanism of production of these deformities and of the cystoscopic and urographic pictures which result from them correct interpretation is impossible.

The congenital abnormalities of the upper urinary tract will be considered under the following heads:—

I. MALFORMATIONS OF THE KIDNEY—

1. Fused kidney

   a. Central — { Discoid / Shield / Horseshoe }

   b. Unilateral crossed ectopia — { S-shaped or sigmoid kidney / Long or long simple kidney }

2. Ectopic kidney

3. Congenitally underdeveloped kidneys — { Hypoplasia / Aplasia / Agenesis—solitary kidney }

4. Absence of both kidneys

5. Supernumerary kidney

II Malformations and Displacements of the Ureter—
1 Associated with a misplaced kidney
2 Duplication and bifid ureter
3 Errors of implantation

GENERAL EMBRYOLOGY

The ureteric bud appears early in the second month of fœtal life as an outgrowth from the dorsal aspect of the lower end of the mesonephric (Wolffian) duct (*see Fig* 253, page 410) But it does not long retain its connection with this structure Migrating along the duct till it reaches the cloaca the ureteric insertion severs its connection with the Wolffian elements and moves upwards to that part of the urogenital sinus which ultimately forms the bladder This migration may in part or wholly fail and the ureter then ends ectopically (*see* page 410 et seq) The developing Wolffian buds grow towards the nephrogenic mass (caudal end of the intermediate cell mass), which is simultaneously forming in front of the sacrum From the former arise the ureters, renal pelves and collecting tubules, from the latter the proper functioning elements of the kidneys.

Early in fœtal life the developing kidneys lie close together in front of the sacrum The pelves face anteriorly and short ureters emerge from them to descend in front of the respective lower poles to the bladder In birds the caudal position of the kidney is retained but amongst the higher animals this gland shortly ascends to the loin possibly to clear the pelvis for pregnancy and parturition as amongst the gravest dangers arising from a kidney retained in the pelvis are the complications caused by its presence during gestation and delivery During the greater part of its journey the kidney pelvis retains its primitive forward aspect, but as the loin is approached a gradual movement of rotation causes it to assume its adult inward direction Ascent may be incomplete on one or both sides, with the result that either kidney may be found in the true pelvis, at the junction of the false and true pelves in the iliac fossa, or in the lower lumbar region The condition is then called ‘ ectopic kidney (ἐκ τόπος out of place) *Fig* 223 shows a right kidney in the condition of lumbar ectopia, the original anterior disposition of the pelvis persisting. The left kidney has reached its correct level in the loin but the final act of rotation has failed

In the earliest stages nothing separates the two renal buds except the developing aorta Sometimes they are in actual contact and fuse. The junction almost invariably takes place anterior to the aorta, but in a few instances it has been posterior The organs then remain united in adult life (fused kidney) The degree of this fusion is variable If it is complete a discoid organ results—‘ cake-like

kidney' (*rein en galette Kuchenniere*) The term 'shield like kidney' indicates an organ of similar type but slightly notched at its upper pole When the separation is further advanced a horseshoe kidney (*rein en fer a cheval Hufeisenniere*) results In the 2 cm fœtus the caudal poles lie closer together than the cephalic (Hauch) and this

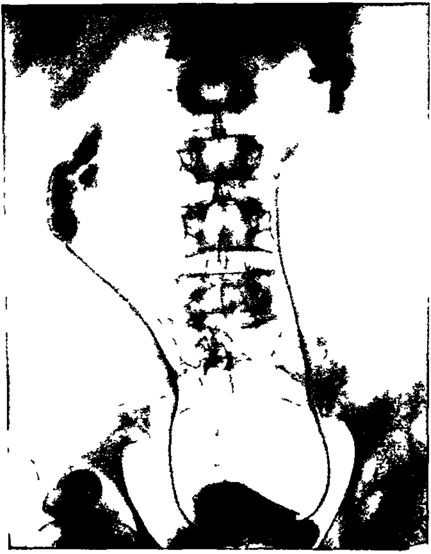


Fig 3—Bilateral renal deformity The right kidney is incompletely ascended and has not rotated properly The pelvis lies well away from the spine and shows moderate pyelectasis Left pelvis is fully ascended but unrotated No dilatation The condition is similar to that seen in horseshoe kidney but the distance of the pelvis from the spine seems to preclude this diagnosis A lateral view however showed the catheters to lie anterior to the spine possibly an instance of a long fibrous union Isthmus parenchyma not visible Right pyelitis No operation but exploration of other kidneys giving similar radiographic pictures has verified the origin of the pelvis from the front of the organ

persists till the fœtus is about 32 cm long (Zondek), which accounts for the fusion of the lower ends In any of the above-mentioned conditions two ureters emerge from the common anterior renal surface at a point slightly lateral to its centre and pass downwards to the bladder in front of the lower portions of the respective kidneys. Such deformities occupy a central, prevertebral, or presacral position in the body

Certain other fusion deformities in which both organs occupy the same side of the body also occur (unilateral fused kidney) This group differs from the centrally placed group in that, whilst the former are united by similar poles—that is, lower to lower, or upper to upper—the unilateral variety shows fusion between dissimilar poles—the upper pole of one kidney and the lower pole of the other. It appears probable that in this latter instance the two kidneys have individually migrated from the pelvis and that one has become displaced laterally so that it finds itself on the wrong side of the spine (crossed ectopia) The two kidneys lie in apposition, one above the other, generally united but not always so This union therefore takes place subsequently to their migration from the pelvis, the fusion involving dissimilar poles If the two pelves face in opposite directions, a kidney shaped like an S ('S-shaped' or 'sigmoid kidney') results. If they point in the same direction, the so-called 'long' or 'long simple kidney' is produced

When the primitive kidney occupies the pelvis it is supplied by the common and internal iliac arteries, chiefly the former As it ascends, a succession of branches, derived from the iliacs and the aorta, bud out to supply it, and the lower branches one by one disappear as they are replaced by others springing out at a higher level Any of these earlier branches may persist as the main or as an accessory arterial supply This evolution explains vessels arising from the internal, external, or common iliac trunks, from the mid-sacral artery or from the lower aorta Such vessels not at all uncommonly run to properly formed and normally situated kidneys, but with ectopic and malformed organs supernumerary vessels and vessels arising below the usual site are almost invariably present

An anomalous vascular supply is important from the operative standpoint, as accessory branches are much exposed to injury when the renal poles are being cleared The majority are of small size and the resulting bleeding is of little moment, but when they happen to be large severe hæmorrhage occurs and may be difficult to control in the depths of the wound. The loss of small tributaries appears to be of little consequence to the vitality of the kidney, though when a large branch is severed necrosis of the portion supplied by it may occur Accessory vessels crossing the ureter are frequently associated with pyelectasis (*See* Plate XV, page 448)

I MALFORMATIONS OF THE KIDNEY

HORSESHOE KIDNEY

In the deformity called horseshoe kidney the two kidneys are more or less intimately fused by similar poles and the resulting structure assumes the shape from which it derives its name It is the most important and frequent of the major malformations of the kidney Its occurrence has been known since 1522 when a case was described by Beringer de Carpi

Incidence —During the present century the post mortem records of several large hospitals have been searched by various investigators and the incidence of this deformity in the general population has thereby been estimated The following statistics may be cited —

OBSERVER	YEAR	BODIES	HORSESHOE KIDNEYS
Morris	1901	18 244	19
Botez	1912	50 704	72
Carlier and Gerard	1912	68 000	80
Efremoff	1912	91 220	125
Stewart and Lodge	1923	6 500	14
Sokolow	1928	50 198	53
Nation	1944	15 528	34

Totalling up the above figures we find that 397 instances of horse shoe kidney occurred in 300 394 cadavers or 1 in 756 6

In striking contrast to these figures are those supplied from the operating theatre where according to Israel 5 horseshoe kidneys were observed in 800 operations according to Marion 1 in 100 kidney operations whilst Federoff in 558 cases has encountered the condition 5 times At the Mayo Clinic 17 horseshoe kidneys were found in 2424 renal operations (1 in 142) The disparity between the post mortem and surgical figures is apparently to be accounted for by the susceptibility to disease which these dystopic organs exhibit

The incidence may also be estimated by examining a series of pyelograms In 1410 consecutive pyelograms Dees found 4 horseshoe kidneys or 1 in 352 5 subjects

Men are affected $2\frac{1}{2}$ times more often than women

Anatomy (*Fig* 224) —

The Kidneys —In the section on the development of the kidney (page 374) the process by which the two kidneys become fused in early fœtal life has been described In 90 per cent of specimens (Robinson) the lower pole only is fused so that the concavity of the united glands points upwards The condition found in many low vertebrates e g the dogfish is thus imitated (the kidney however in these is a

mesonephros). In the remaining 10 per cent the upper poles are fused and the concavity faces downwards Swift Joly quotes Gruber, who is sceptical about the accuracy of some of the earlier cases which may have been mounted upside-down The figure of 10 per cent is probably much too high The isthmus almost invariably lies in front of the great

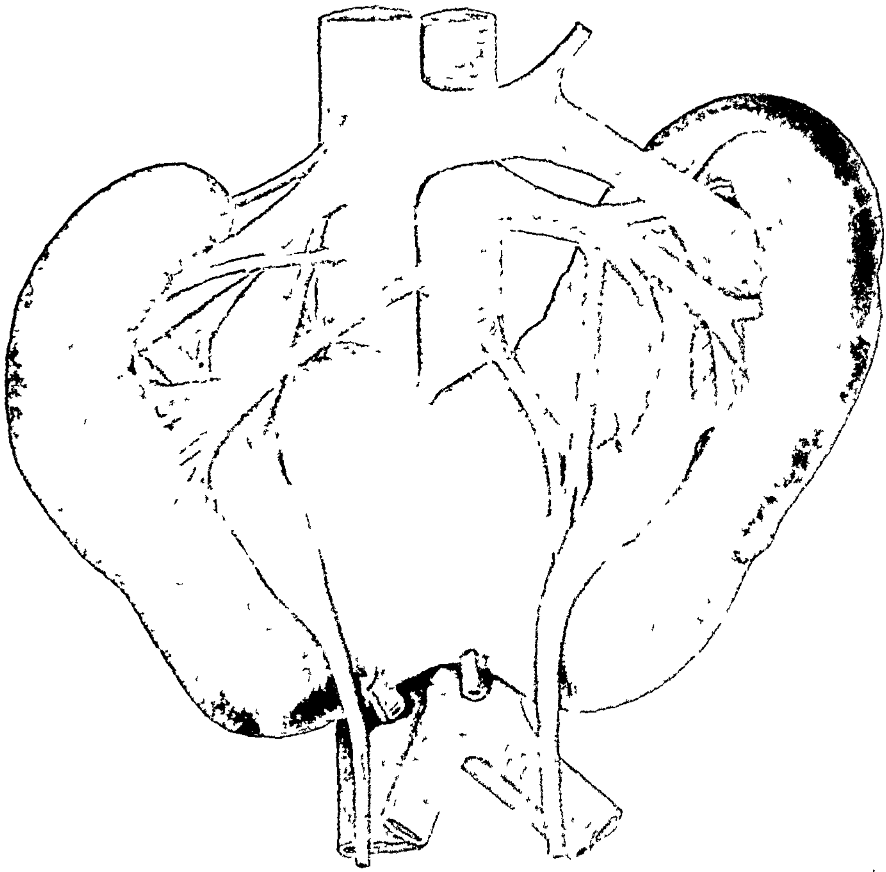


Fig 224 —Horseshoe kidney showing the following features common to most examples Isthmus lying in front of great vessels (here, large and fleshy) The ureters, lying anterior to the lower poles, occupy grooves (which sometimes cause back pressure) and are very close to midline of body The pelvis faces forwards, the lowest calix passing inwards to drain the isthmus The kidneys are held close to the middle of the body by their union and they are incompletely ascended—just above the aortic bifurcation Vascularization is very erratic Note vessels to inferior margin of isthmus which joined up with the iliac blood vessels

vessels * It may consist of fibrous tissue (15 per cent of specimens, Robinson) or of parenchyma Occasionally it is so well developed as to look like a centrally placed third kidney (Sutherland, Perregau,

* There was an exception in the Royal College of Surgeons Museum (No 638), destroyed in an air raid, in which it lay posteriorly, and two other similar specimens (Nixon, Kelly and Burnham) are also known

et al) and instances are on record in which it has been served by an additional ureter

The junction is sometimes stretched tightly across the great vessels obstructing their circulation or causing abdominal pain severe enough to necessitate its division The vertical development of the isthmus is variable It may be so well formed that the kidneys are united almost as high as their upper poles a circle being thus almost completed The condition then approximates to the one known as 'cake like' or 'shield' kidney

The axes of kidneys united by their lower poles are so altered that instead of their upper extremities inclining inwards as in health they come to point outwards (*Figs* 224 226) The two halves of the horseshoe kidney lie closer to the midline than do normally developed organs The distance between them varies with the development of the isthmus but on the average is about 6 cm (Rubascheva) A horseshoe kidney is rarely symmetrical one half being larger and more shapely than its fellow The better favoured kidney adopts a more normal position in the body than its partner It therefore lies at a higher level and is further from the midline Occasionally it appears to drag the other element transversely on to or even across the spine the so called L shaped kidney resulting (*Fig* 225) A horseshoe kidney may lie at the normal level (7 times in 222 cases Legueu and Papin) but the majority fall short of that position by the depth of one or two vertebræ and the isthmus is situated about the level of the aortic bifurcation A greater degree of displacement as for instance on to the sacral promontory or into the true pelvis, is rare Rokitansky states that the more developed the isthmus is the lower the organs lie

Fig 225 —Horseshoe kidney Retrograde pyelogram The right kidney lies higher than the left and has dragged the latter on to the sacral promontory The left is somewhat dilated Probably an L shaped kidney No operative confirmation

The horseshoe mass lies on a plane which is much anterior to that assumed by the normally situated organ This is a fact which though obvious enough receives practically no notice in any descriptions Instead of lying in the deepest recesses of the loins the kidneys are

perched not only on the prominence of the lumbar spine, but in addition overlie the great vessels. The isthmus is the most anteriorly placed section, the lobes inclining slightly away The usual inward rotation of the pelvis, almost a final movement in the process of ascent, is forbidden by the fusion of the two organs, the hilus therefore faces forwards, or forwards and inwards

The Ureters—In the common type of horseshoe kidney (caudal union) the ureters retain the relationship anterior to the united lower poles which characterized their early sacral form (*see* page 374) though an instance is known (Landouzy) in which they perforated the renal substance, and two (Perruchot, Rathbun) in which they passed posteriorly In Rathbun's case the pelvis on the right side passed upwards and then the ureter arched over so as to be directed behind

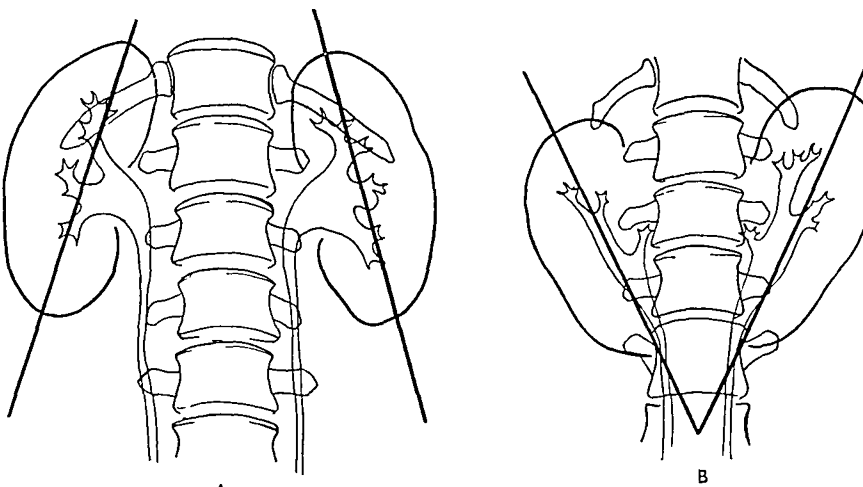


Fig 226—Diagram showing the axes of the kidneys A, In the normal, B, In a horseshoe kidney

the kidney The ureters below the isthmus are not as a rule dilated, and in this contrast with the pelvis, which commonly shows a greater or less degree of pyelectasis, caused either by an abnormally acute uretero-pelvic junction or by pressure exerted on the ureter where it crosses the isthmus Evidence of such pressure exists in the fact that the ureter produces a furrow in the renal substance

The *vascular supply* of a horseshoe kidney is erratic and very variable, a fact which gains considerable importance because of the danger to which the vessels are exposed at operation For the most part the *arteries* spring from the common and internal iliac trunks, chiefly the former, and also from the lower aorta and the mid-sacral artery Exceptionally a branch arises from the inferior mesenteric artery The latter trunk is closely applied to the upper margin of the isthmus and actually leaves its imprint on the renal tissue (Legueu)

This observation gains interest when it is realized that the horseshoe mass in its journey from the pelvis is unimpeded till it encounters this the first vessel springing anteriorly from the aorta. It seems more than likely that the inferior mesenteric vessels constitute the bar to further progress and account for the observed constancy in position of the isthmus in this deformity. This relationship is important when operations are undertaken upon the isthmus for its division etc. The majority of the arteries enter the kidney by the hilus but some perforate its surface. Frequently a special branch passes to the isthmus (*Fig* 224). Papin collected 139 cases of horseshoe kidney and found that the arteries varied in number from one to ten; two to five were often observed but three was the most customary supply. Robinson found one branch to each lateral mass in 10 out of 60 specimens whilst in 4 more there was a single trunk to each lateral mass and a branch to the isthmus. In four fifths of the cases the renal arteries originated distal to the normal situation.

The *veins* are less irregular in their distribution and as a rule unite into two main branches which pass to the vena cava but which may empty themselves into the iliac veins.

Pathological Lesions.—Every variety of renal lesion has been found in the horseshoe kidney. Rathbun collected 108 cases from the literature and has tabulated the diseases which complicated them. The following is his table :—

Calculi	32	Trauma	2
Hydronephrosis	18	Pyelitis	1
Pyonephrosis	11	Ureteric calculus	1
Tuberculosis (one double)	12	Adhesions about ureter	1
Neoplasm	4	Fistula	1
Polycystic disease	3	Uncomplicated	13
Nephritis	2	No details	7

In contrast to this Stewart and Lodge in 14 autopsy specimens found gross kidney disease in 1 case only—chronic nephritis in a woman of 27. The average age of these 14 patients was 47, one patient being 82 and two more between 60 and 70 whilst five were between 50 and 60. The authors conclude from this that the possession of a horseshoe kidney is no bar to long life. Similarly Nation reviewing 34 autopsy cases decided that the average span of life was not influenced by the presence of the renal anomaly.

Malformation elsewhere in the body has been observed but is less commonly associated with a horseshoe kidney than with any of the other major renal malformations.

Symptoms.—Patients come under observation :—

1 Because the deformity itself is occasioning symptoms. (*a*) Pain due to the pressure of the isthmus on the great vessels. Usually located in the umbilical region this is stated to be aggravated

by increasing the anterior prominence of the lumbar spine and to be relieved by recumbency (Rovsing) (*b*) Evidence of pressure on the great vessels—œdema of the lower extremities due to the compression of the vena cava, and cardiac hypertrophy from obstruction to the abdominal aorta (Rovsing, Davidsohn)

The diagnosis may be suggested by the pain described above. A centrally placed abdominal tumour, especially if associated with urinary symptoms, may arouse suspicion The isthmus is rendered prominent by the aorta and in a thin subject may be very evident and may receive transmitted pulsation

2 For any of the diseases which supervene on the abnormality

In a majority of all cases the symptoms are those arising from the complication, and a diagnosis limited to this, and failing to take account of the malformed kidney has in the past been the rule The diagnosis of a horseshoe kidney has been facilitated by the advent of urography In Rathbun's (1924) 108 collected cases only 24 (22 per cent) had been diagnosed prior to operation Judd, Braasch, and Scholl (1922) reported 16 cases, of which 8 (50 per cent) were correctly diagnosed before operation To-day, few cases should be encountered unexpectedly at operation

Urography.—This is the key to the diagnosis An intravenous urogram will probably give a clue early in the investigation but the shadows may be weak and inconclusive, the more so as they overlap or are close to the spinal shadow The denser retrograde urogram will be more decisive, but the risk of introducing sepsis into these easily infected organs should be ever in the mind of the surgeon

The pyelographic picture is complementary to the anatomical arrangements The pelvis is low-lying, abnormally close to the median line, and the axes of the two pelves diverge as they pass upwards The lowest calix reaches across towards the isthmus to drain this unusual area It therefore lies to the inner side of the pelvis and ureter (*Figs* 227 and 228) Some of the other calices (middle and upper groups) may also be inwardly directed owing to the anteriorly rotated renal hilus, but this is not constant Calices lying to the inner aspect of the ureter always suggest a malformed kidney

The pelvis frequently shows a greater or less degree of dilatation (*Figs* 227, 229), together, perhaps, with evidence of concomitant disease—stone* (*Figs* 227–229), tuberculosis etc Lateral pyelography will show that the pelvis is displaced forwards so that its shadow lies in front of the spine The ureters in their upper extent lie close to the midline and generally overlap the spine (*Fig* 229)

* In 1924 Rathbun examined the records of 108 operations on fused kidneys, including horseshoe kidneys, and found that stones were noted in 32 (approximately 30 per cent)

Fig — Oxalate stone in the upper part of the pelvis of a horseshoe kidney. Observe the axis of the pelvis and the inward lying calices. The ureter passing downwards and inwards shows the flower vase feature

Fig —8 —Large stone in a horseshoe kidney. Note faint extension into the calix of the isthmus. On left side calices indicate forward facing pelvis but are not dilated. The shape of the parenchyma can be seen. The mottled shadows on the margin of the left kidney are calcified tuberculous gland

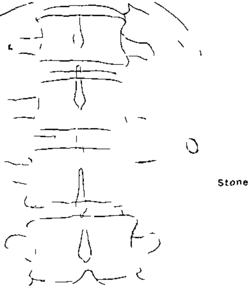


Fig 9 —Horseshoe kidney. Tracing of [illegible] pyelogram. Both [illegible] severely dilated. Small stone in left pelvis. Note [illegible] of the ureters and absence of ureteric dilatation. The organ lies far higher [illegible]. The right component is higher than the left

Gutierrez somewhat aptly describes the radiological picture of the ureters as a "flower-vase figure" The widely separated pelvic portions of these tubes constitute the bowl and they curve upwards and inwards to form the waist of the vase They then diverge to make the "wide flaring mouth" and further continue in the same direction into the outwardly running renal pelvis (*Figs.* 227, 229) At the point where the ureters arise from the pelvis they are situated in front of the spine and great vessels and are therefore relatively close to the anterior abdominal wall To reach their customary position in the pelvis they have to pursue a markedly rearward course These facts are not recognized in an anteroposterior radiograph, but the course of opaque catheters in the ureters when seen in a lateral view brings out this feature

Operative Treatment.—Operations on the horseshoe kidney are more risky than those on the normally placed organ owing to the immobility of the gland and its rich and variable vascular supply Two possible routes are available for choice, the lumbar and the transperitoneal There is some difference of opinion as to which is the better. The fear of leakage and peritonitis deters some surgeons from using the *transperitoneal* approach, but this can be guarded against by employing a stab drain through the loin and has not, in the author's experience been troublesome The kidney lies immediately under the posterior layer of the peritoneum and when this is incised it is quickly displayed and is usually mobilized without difficulty The vascularity of the front of the pelvis varies considerably, many times being slight, at others consisting of a more or less thick network, but it is in full view In general the blood-supply of the kidney is posterior, which is fortunate The transperitoneal route is obviously the method of choice where bilateral operations on the pelves are contemplated, or for symphisiotomy

By the *lumbar* route the anteriorly placed pelvis, perched high in front of the spine, is remote and inaccessible The incision must be extended forwards beyond the usual distance If the horseshoe kidney is encountered unexpectedly at a lumbar operation the surgeon becomes aware that, whereas the upper end of the organ is mobilized even more readily than usual, the lower refuses to come into the wound, and indeed no true pole can be identified If the condition is not quickly recognized, injury may occur to various structures, especially accessory vessels and the ureter, during the attempt to deliver the kidney As soon as the abnormality is recognized the incision should be enlarged anteriorly Stones are most easily reached by nephrolithotomy, but if pyelolithotomy is preferred the peritoneum should be gently elevated by gauze dissection till the pelvis is identified Ureteric stones not infrequently lodge at the point where the

ureter crosses the isthmus and are then reached by working along the anterior surface of the kidney

In nephrectomy the main difference from an ordinary operation is the treatment of the isthmus which is best approached across the peritoneum If it consists of fibrous tissue it may be snipped across if of parenchyma its division may occasion free hæmorrhage To obviate bleeding the isthmus may be crushed with a clamp A better method is to make an angled section combined with the use of interlocking sutures In symphisiotomy the isthmus is similarly treated Occasionally urinary leakage and a troublesome fistula may result Lumbar drainage should therefore be employed

UNILATERAL FUSED KIDNEY

(*Crossed Ectopia*)

In this condition the two kidneys are united* into a single mass which lies on one or other side of the spine It is a rare deformity of which Papin and Palazzoli in 1910 were able to collect only 70 examples but in 1940 Foley and Wilmer reviewed 286 cases The left kidney is transposed twice as often as the right

Anatomy —The fusion is almost invariably in the vertical direction, so that one kidney lies higher than the other In 87 per cent of cases the upper kidney has belonged to the side on which it has been found and its ureter has passed down directly to the same side of the bladder to be inserted in the normal position The lower of the two organs belongs to the opposite side and its ureter invariably crosses the midline to obtain insertion in its own side of the bladder in the normal situation The upper kidney is larger than its fellow The two together form a mass of greater length than that of a single kidney

The size of the two may be equal to but is often less than the combined size of two healthy and normally situated kidneys It is never greater unless they are hydronephrotic or otherwise diseased In the majority of specimens the junction is easily discerned but in a few there is no evident dividing line The lower kidney is occasionally enveloped by the upper in such a manner as to disguise the true condition In five cases (Foley and Wilmer) this has led inadvertently to pannephrectomy

The *pelves* are separate and distinct Cases have been reported in which they communicated but these should be discredited The

* Gottlieb calls attention to the fact that the primary condition is the renal ectopia One kidney is displaced from its usual situation and comes to lie on the opposite side of the body where it finds itself in close apposition with the other kidney Fusion results but is secondary Pagel in examining 55 records showed that in 14.5 per cent there was no fusion

upper pelvis faces more or less in the usual direction, though there is a tendency for it to be rotated forwards In some instances it lies externally The lower pelvis is more erratic and may look inwards, outwards, downwards, or forwards Backward-looking pelves have been described by Albarran and Wehn. When both pelves are directed inwards the condition has been called the 'long simple kidney'. When they face in opposite directions it is called the 'S-shaped' or 'sigmoid kidney'. With any of these arrangements, but particularly when the lower pelvis is directed away from the spine, the corresponding ureter may have to cross the ureter of the upper organ to gain the midline of the body The combined mass rarely attains the proper kidney position. In many instances it occupies the iliac fossa

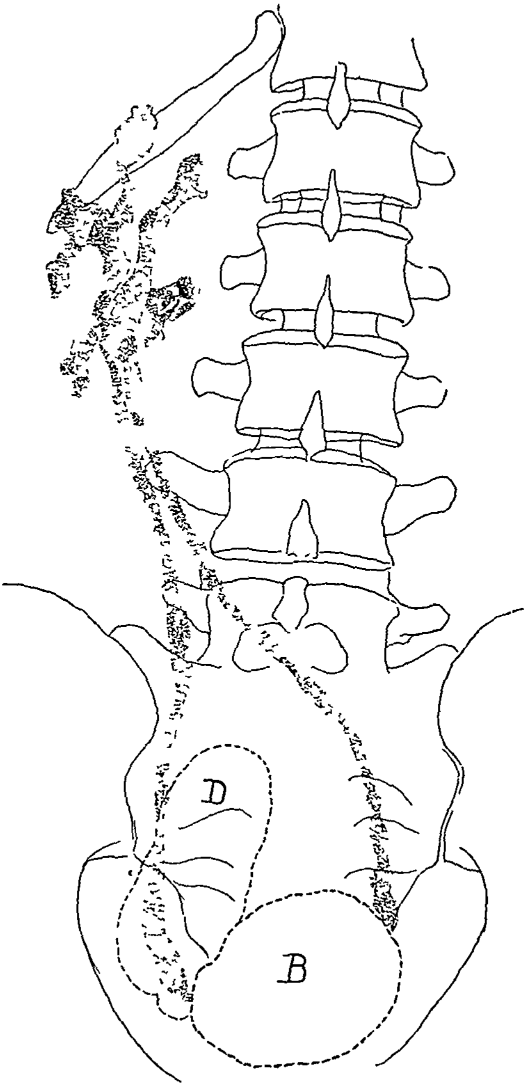


Fig 230 —Crossed renal ectopia The kidneys appear to be at the same level, which is unusual, and they may constitute a fused mass The ureter of the ectopic kidney crosses the midline to reach its proper insertion in the bladder (B) D is an appendage to the bladder, a diverticulum of unusual shape, which proved at operation to be urachal in origin
(*The late E D McCrea's case*)

This malformation must be carefully distinguished from that in which a solitary kidney is provided with two ureters. The two conditions are genetically distinct The term 'unilateral horseshoe kidney' has sometimes been erroneously applied to unilateral fusion of the kidney, the distinguishing point being that in the latter condition dissimilar poles are fused—that is, the upper pole of one kidney is united to the lower of the other, whereas in a horseshoe kidney similar poles are joined to each other—lower to lower, or upper to upper

The *vascular supply* is erratic, but often rich, additional arteries being frequently observed. The supply for the upper segment

generally springs from the aorta at or below the customary site, whilst that for the lower portion is more capricious and may take origin from the aorta low down—perhaps from the bifurcation—or from the iliacs of the opposite side In two thirds of all cases the whole blood supply comes from the aorta

Complications —Malformations of the *genital* apparatus which are so commonly found associated with a true solitary kidney, are much less frequent in the fused kidney, but are nevertheless fairly numerous In the male absence of the vas and atrophy of the left lobe of the prostate (Tandler) and hypospadias (Sutherland) have been observed in the female uterus unicornis and absence of corresponding tube and ovary (Turner) and atrophy of one horn of the uterus (Stolz) The urogram in *Fig* 230 shows an associated urachal diverticulum General malformations have also been reported such as transposition of viscera (Wehn) etc

Concomitant disease has been observed in the kidneys as for example nephritis tuberculosis hydronephrosis pyonephrosis growth and stone A stricture of the ureter of congenital origin complicated a case reported by Krause

Diagnosis —There are no symptoms which would suggest a fused kidney but the presence of a tumour in the iliac region has been observed in many cases Cystoscopy does not help as the ureters are normally situated The sheet anchor in diagnosis is urography (*Fig* 230) which brings to light not only the crossed ectopia but also any malformation of the renal pelves and perhaps evidence of associated disease

ECTOPIC KIDNEY *

Embryology —The embryology of this condition is not difficult to understand The kidney has failed to carry out its customary ascent from the pelvis to the loin as also the rotation of its pelvis from the anterior to the median aspect It is therefore to be distinguished from a movable kidney an organ which having reached its normal position has wandered again therefrom In contradistinction to this failure of ascent a few cases are on record in which the kidney is known to have overshot its mark the condition being then called high lumbar ectopia In one instance such a kidney passed into the chest through a congenital orifice in the diaphragm (Campbell)

Incidence —Ectopia is a moderately common malformation there are several hundred records of such cases and these have multiplied rapidly since the routine adoption of urography Guizetti and Pariset found 18 examples in 20 000 necropsies in 1910 that is 1 in 1100

* The term simple ectopia is sometimes used to distinguish the non ascended kidney from crossed ectopia (page 385)

bodies, and numerous subsequent statistics confirm an incidence of about 1 in 1000 autopsies, for instance Eisendrath's, who found 205 examples of simple ectopia in 207,321 post-mortem reports Up to the last two decades females appeared to preponderate because ectopia was chiefly discovered when it complicated pregnancy or labour, but the last twenty years have seen an excess of males in the published cases, presumably brought to light by the more precise means of diagnosis now available

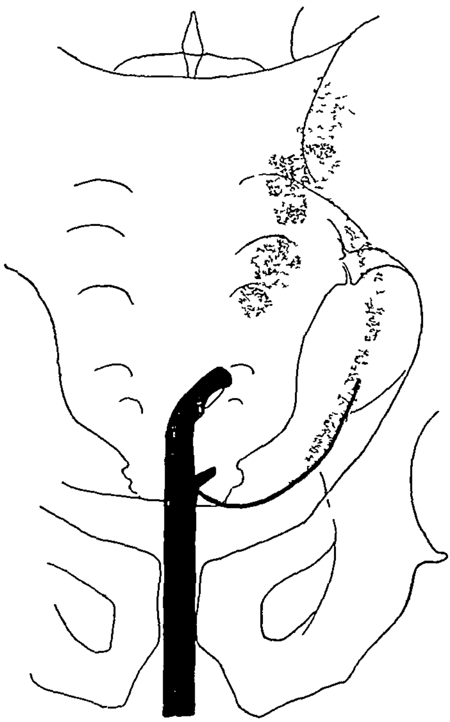


Fig 231 —Pelvic ectopia The ureter pursues a curved course and approaches the pelvis from the outer side The pelvis is dilated Symptoms renal colic referred to the corresponding loin, and pyuria

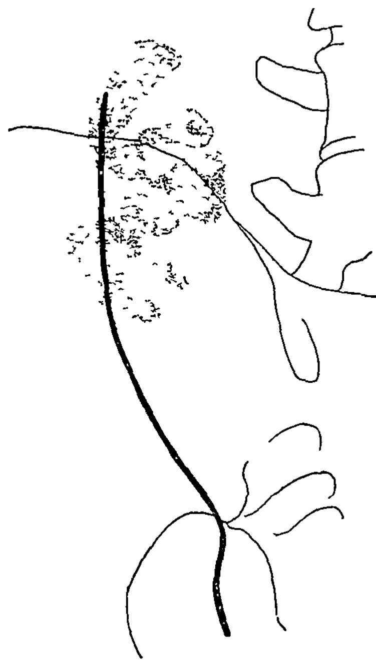


Fig 232 —Right, low-lumbar ectopia Pyelectasis All calices face inwardly

The left kidney is affected more often than the right. Sokolow (1930) says that the incidence on the left side is 1 in 848 autopsies, that on the right 1 in 2035 The condition occurs bilaterally in 1 in 3392. When both kidneys are displaced the left tends to be the more severely involved

Anatomy.—

Position—The kidney may lie at any point between its site of development opposite the second sacral vertebra and its normal position in the loin We speak, therefore, of a pelvic (*Fig* 231), low-lumbar (*Figs.* 232 and 234), or iliac (*Figs* 233, 235) ectopia,

Shape —The more extreme the degree of its displacement the more the kidney deviates anatomically from the normal The lower it lies, the closer it is to the midline (*see Fig* 234) The ectopic kidney is smaller than usual Its hilus faces anteriorly with the more severe grades of displacement but approaches the inner border more and more as the kidney nears its proper position The anterior surface is smooth but may be lobulated the posterior is smooth and flat or may be moulded to the structures against which it rests The shape of the kidney is very variable but it is generally elongated and may be oval or quadrilateral Its original form may be much modified by disease There is little or no perirenal fat the organ being in close contact with the parietal peritoneum It is adherent and in this contrasts with the ptosed kidney In one case (Boyd) perirenal fat was found in the correct situation

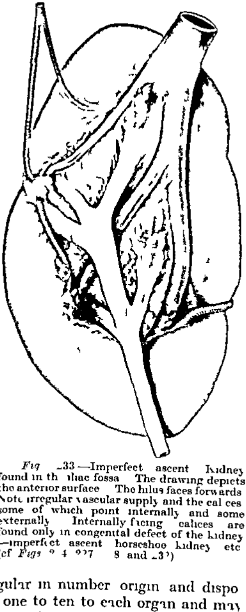


Fig 233 —Imperfect ascent kidney found in the iliac fossa The drawing depicts the anterior surface The hilus faces forwards Note irregular vascular supply and the calices some of which point internally and some externally Internally facing calices are found only in congenital defect of the kidney —imperfect ascent horseshoe kidney etc (cf *Figs* 2 4 227 8 and 23[illegible])

The *ureter* arises anteriorly Shorter than the normal structure it takes an approximately direct course to the bladder It is distinguished from the ureter in nephroptosis by not being redundant When the kidney lies in the pelvis the ureter is not more than a few inches in length Occasionally however the ureter pursues an upward course in the first instance and then loops over and runs to the bladder (Campbell Dreyfuss Israel et al)

The *arteries* are extremely irregular in number origin and disposition They vary in number from one to ten to each organ and may enter the hilus surfaces or borders According to the position of the kidney they arise from the mid sacral inferior mesenteric or iliac arteries or from the lower reaches of the aorta The *venous distribution* corresponds roughly to that of the arterial

The *suprarenal gland* is almost invariably found in its correct position

The *opposite kidney* is for the most part in its proper place, but it not infrequently shows some grade of ectopia The smallest degree is a failure of the final rotation and this is quite common It gives the radiographic picture shown in *Fig* 223 If both organs are ectopic they may lie at the same level or at different levels, the latter being the more usual. The left is the lower in a preponderance of cases. Of cases of bilateral pelvic ectopia there are 40 instances

A B

Fig 234 —Soldier, aged 24 Gross pyuria Cryptorchism, aspermia A, Oval shadow in the presacral area (arrow) B, Retrograde pyelogram showing the dilated pelvis of an ectopic left kidney lying over the bodies of the fifth lumbar and first sacral vertebræ Note the ballooned calices, the large pelvis and the coiled up catheter When A is made to overlie B the position of the stone is found to be at the uretero-pelvic junction Transperitoneal nephrectomy

on record (Fowler, 1941, 22 clinical and 18 post mortem) When both kidneys occupy the pelvis they may be closely approximated to each other, but the rectum usually separates them A kidney has been observed posterior to the rectum and through its pressure has been responsible for obstruction to the gut In 2 instances a kidney has been provided with a mesentery and has undergone torsion (Ransohoff, Forbes). Lemberger found a kidney lying behind the aorta

The kidney of the opposite side occasionally fails and the prolapsed gland is then referred to as a *solitary ectopic* kidney The degree of failure, however, is not necessarily complete, hypoplastic and aplastic organs having been noted (*see* page 392) In 1937 only 27

instances of this combined deformity could be traced by Stevens He estimated that it occurred once in 22 000 bodies During the subsequent ten years reported cases have advanced to 46 (Hanley and Steel) which indicates that they are less uncommon than the paucity of the literature would suggest A correct *pre operative* diagnosis was made in less than 50 per cent

Complications —There are numerous records of concomitant malformation in the genital organs particularly in the female where associated deformity is almost invariable the uterus vagina and tubes being partially or completely undeveloped The Mullerian duct is differentiated about the time that the kidney starts its migration cranialwards (fifth week) and this is thought to account for the frequency with which deformities affect that channel In the male the testicle may be atrophic undescended (*Fig* 234) or absent The two deformities are invariably homolateral Stephan estimated this incidence at 38 per cent

Fig 235 —Tuberculous kidney Whole organ converted into a putty like calcified mass Note ureter enormously thickened also filled with similar material Upper ureter rises running a circuitous course to a point just below the sacro iliac joint where it was strictured Kidney is centred at the level of the iliac crest and probably is an example of ectopia but the fact that the pelvis faces medially against the spine Left kidney lies opposite third lumbar vertebra and is correctly rotated The objects seen in the retropubic area are calcified tuberculous deposits (stones) in the prostate which were causing obstruction to micturition Calcified glands to left of spine

Complications in the kidney itself are very common Straeter places them at 31 per cent of all pelvic kidneys but Bugbee and Loser found 23 ectopic kidneys 21 of which were infected Hydronephrosis (*see Fig* 232) pyonephrosis and stone (*Fig* 234) are common whilst a neoplasm has several times been seen A tuberculous example is seen in *Fig* 235

A misplaced kidney is a serious complication in pregnancy and labour It may obstruct delivery and necessitate Cæsarean section

Pressure exerted on the kidney may cause severe damage to that organ, and necrosis has been recorded (McCown). Rupture of the uterus or kidney has also been noted (Albers Schonberg) There is a high incidence of spontaneous abortion at an early stage amongst all varieties of low-lying ectopia The dangers of pregnancy should be explained to women affected with this malformation

Symptoms.—The symptoms are anomalous Pain may be felt at the site of the misplaced kidney, but is more often referred to the loin, in the situation customary for renal pain. Pelvic ectopia may give rise in women to dysmenorrhœa and dyspareunia The kidney has frequently been palpated low in the loin, in the iliac fossa, or by vaginal or rectal palpation, and may be immediately and easily recognized, as was the case with the kidneys shown in *Figs* 231 and 235 Its identification is, however, not always easy In the female pelvis the swelling is liable to be regarded as having a gynæcological origin

Pyelography (*Figs.* 231, 232, 234), should supply the key to the diagnosis By it the position of the kidney, the congenital malformation of the pelvis, as well as any acquired lesions are rendered evident. Gottlieb showed that up to 1911 this examination had been employed in 12 per cent of cases, in a further series running up to 1924 it was used in 30 per cent, and of 50 fresh cases up to 1927 48 per cent were correctly diagnosed by this means.

Treatment.—This will be dictated by the symptoms, the presence of concurrent disease, and the state of the other organ The extraperitoneal approach to the iliac kidney is the best, but the transperitoneal is recommended when the kidney is low over the sacrum Stones are very accessible in the anteriorly placed pelvis, but a sharp lookout must be maintained both in this operation and in nephrectomy if the rich and irregular vascular supply is to be safeguarded The deeply placed pelvic organ is not easy to treat because of its short ureter and its fixity

CONGENITALLY UNDERDEVELOPED KIDNEYS

Considerable confusion regarding the nomenclature of renal defect has existed in the past, the three terms, hypoplasia, aplasia, and agenesis, having been interchangeably or at least loosely applied They have now been more accurately defined on the suggestion of Gutierrez and the meanings he has attached to the terms are accepted in America and will be adopted in the present description

In the production of these defects it is possible for either or both of the two elements which go to form the kidney to fail the metanephros, giving origin to the main parts of the parenchyma, or the Wolffian bud (*Fig.* 253, page 410), which produces the ureter, pelvis,

and collecting tubules If the metanephros is deficient the kidney may be absent (agenesis) or may be represented by an underdeveloped organ (hypoplasia) In hypoplasia the ureter and pelvis are always present though they may be undersized or infantile in type In agenesis the ureter and other collecting elements may be found in any grade of development but are more often than not missing When the other element the Wolffian bud is faulty the collecting system is primarily affected and is partially or completely wanting The metanephros may be simultaneously absent (agenesis) but has in many cases started to develop normally Receiving no collecting elements it aborts (aplasia)

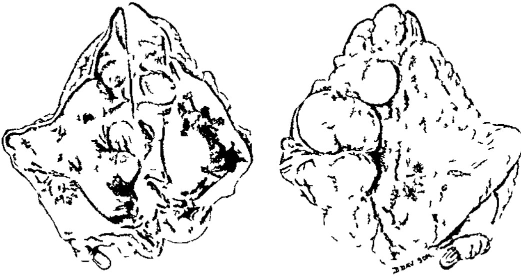


Fig 236 —Renal hypoplasia Operation specimen from a patient whose urogram is shown in *Fig* 3 A thin fibrotic shell containing practically no true renal tissue and showing indications of lobulation The whole organ was only 1¼ in long

Hypoplasia —If a metanephros is partially defective a more or less underdeveloped organ will represent the kidney and the name hypoplasia is applied to the condition The kidney consists of a thin walled functionless sac (*Fig* 236) The ureter and pelvis are present and patent but the pelvis may be rudimentary and show irregular features

The opposite kidney is hypertrophied to take over a double share of work but is very susceptible to disease—infection stone etc —and Anders has shown that 42 per cent of such organs are the seat of advanced chronic nephritis The hypoplastic kidney may be found accidentally when investigating disease in its fellow but as pointed out by Mackenzie and as observed in several cases in the writer's experience it is a cause of pain referred to the corresponding loin the pain being relieved by removal of the deformed kidney

shadow on the affected side tends to be broader than its fellow and this has been confirmed by others

Bladder.—The bladder findings are highly important to the clinician and may supply the first intimation of abnormality. The ureter of the solitary kidney is discovered most commonly at its correct site and the corresponding half of the trigone is fully developed The opposite half of the trigone may be normally shaped, but is generally more or less atrophic, the interureteric bar then disappearing at or about the midline (*Fig* 239). It requires emphasis that although the ureteric orifice of the missing kidney is usually absent, in 10 per cent of cases it is present The discovery of an opening does not, therefore, justify the assumption that a kidney is present The bladder is occasionally deformed or absent, the ureter in the latter case ending ectopically

Genital Malformations.—In view of the embryology of the urinary and genital apparatus it is not surprising that malformations should be shared in common Malformations of the genital tract both in the male and in the female are more common in association with the unilateral absence of a kidney than with any of the other dysplasias of the urinary organs Winter estimates that they occur in about one-third of all cases The importance of this fact to the surgeon was not appreciated until Ballowitz's important paper (1895) From the literature this writer collected 213 cases of congenital unilateral absence of the kidney. In 110 of these no mention was made of the condition of the genitalia In the remaining 103 cases a malformation of the genital apparatus was remarked in 73, 28 being males and 41 females, whilst the sex was left unstated in 4 These figures appear to indicate a preponderance of deformities amongst women, which, however, Papin questions, since genital abnormality assumes more importance in the female than in the male

Recent work appears to point to a greater proportion of associated genital malformations in men, which might be expected on embryological grounds, for the primitive ureter is more closely connected with the Wolffian duct (vas deferens) than with the Mullerian duct (vagina, uterus Fallopian tube, etc.) Figures are contradictory Hennessey reports that 48 per cent occur in women, Collins figure being 89 per cent In the male the chief defects concern the epididymis, vas deferens, common ejaculatory duct, and the seminal vesicles, any or all of which may be absent or atrophic The corresponding side of the prostate likewise fails to evolve whenever the efferent channels are undeveloped Testicular atrophy invariably accompanies these hypoplasias In the female the principal defects are small size or absence of the corresponding uterine horn and its Fallopian tube double uterus, double vagina, and non-development of the uterus or

vagina, or both. One or both ovaries may be displaced or absent. Genital malformation is therefore important corroborative evidence of congenital renal anomaly.

Severe general malformations have been frequently reported and include anencephaly, hydrocephaly, spina bifida, imperforate anus, malformations of the heart and great vessels, the transposition of viscera, etc.

Symptomatology and Diagnosis. Disease is frequent in solitary kidneys and practically all known renal lesions have, at some time or other, been seen in them. The malformation as such rarely causes trouble. The patient presents himself for a symptom or group of symptoms which does not suggest any anomaly but which characterizes the particular disease. If the latter leads to lowered renal function, uræmia shows itself early; if to ureteric obstruction, anuria occurs forthwith. External examination is rarely helpful, though a large renal swelling associated with an empty opposite loin may arouse suspicion. The anomaly has usually in the past been overlooked. Out of 378 collected cases only 5 *were recognized during life*. Correct diagnoses should, however, nowadays be possible by the following methods:—

1. Cystoscopy, showing absence of one ureteric orifice or of one half of the trigone, evidence which, as above stated, may be absent.

2. Absence of an efflux or other signs (chromo-cystoscopy, catheterization, instrumental pyelography, etc.) of a functioning kidney corresponding to a normally placed meatus.

3. Catheterization of the existing kidney may be undertaken to obviate the possibility of having overlooked a misplaced or concealed ureter. A control catheter in the bladder may confirm the lack of any further supply of urine. This test is of value only when positive, that is, when no urine comes from the control catheter, as urine coming from the bladder may represent leakage down the ureter around the ureteric catheter.

4. Radiographic absence of one renal shadow.

5. Evidence, especially radiographic, of a hypertrophic kidney on the other side. A large pelvis in the absence of pathological dilatation is strongly confirmatory.

6. Excretion urography is of outstanding importance when a ureteric orifice cannot be discovered, as, if a kidney exists, it may reveal its presence, whereabouts and condition. It will of course fail if the kidney is functionless, though a functionless kidney may be regarded, for practical purposes, as absent.

7. Search for concomitant malformation, especially genital.

8. Exploration.

Treatment. *The treatment of disease occurring in a solitary kidney calls for discretion and ingenuity.* Many operations have

been practised on these organs with success On not a few occasions they have been unwittingly removed

ABSENCE OF BOTH KIDNEYS

The absence of both kidneys constitutes an abnormality of no surgical interest, as the individual survives but a few hours or days Coen collected 33 cases from the literature in 1884 and Soloway in 1939 brought them up to 121. The deficiency is as a rule, not confined to the kidneys. The ureters are generally absent, and in most cases the bladder also. Multiple deformities are usually observed. The condition also occurs in the lower animals (Garcia)

THE SUPRARENAL GLAND IN CONGENITAL UNDERDEVELOPMENT OF THE KIDNEY

The suprarenal gland should be important in a condition which so often terminates fatally from hyperpiesia The facts are not easy to determine as many cases are carelessly reported or improperly classified On theoretical grounds one might anticipate that if the renal defect were primarily metanephric the suprarenal might tend to be small or wanting, whereas if the Wolffian development were faulty the suprarenal would be unaffected This appears to be approximately what happens Thus in Nation's nine aplastic kidneys (Wolffian defect) which were examined post mortem the suprarenal was present in all, whereas in most, though not all, reported 'solitary kidneys' the suprarenal on the opposite side was absent In some hypoplastic kidneys the adrenal is small (e g , Huff and Boger's case). The matter however, requires more careful working out

SUPERNUMERARY KIDNEY

This is the rarest type of renal anomaly In 1930 Parin reviewed the literature, and, after excluding many doubtful records and others falsely described as supernumerary, he collected 25 apparently authentic examples In the same year Kretschmer added a personal case and increased the list to 30 whilst in 1940 Hanley brought it up to 43

By the term 'supernumerary kidney' is understood an independent organ provided with separate fibrous and fatty capsules pelvis and blood-supply, and having no connection with the other kidney of the same side. The latter occupies its customary position in the loin and is approximately normal in size (4 cases are reported where it was notably diminished). The size of the supernumerary organ varies from that of a bean to that of a fully developed kidney The shape is reniform though it may show lobulation In Parin s collection 13 supernumerary kidneys lay to the left 8 to the right, of the spine and 4 in the midline Only 3 occupied a position in the body higher

than the normal organ The pelves of the two kidneys were separate in all examples In less than half the cases separate ureters ran to the bladder in the remainder the ureters combined before reaching that viscus but in 2 cases an extravesical insertion into the vagina was observed Some additional pathological complication has been observed in about three fifths of the reported cases and may in many instances be suitably met by removal of the supplementary kidney Kretschmer, however showed that disease was also present in the other kidney on the same side in about a third of the cases

Supernumerary kidneys have been observed in the cow (Pieth) and pig (von Hansemann)

II CONGENITAL MALFORMATIONS AND DISPLACEMENTS OF THE URETER

ASSOCIATED WITH A MISPLACED KIDNEY

When a kidney is misplaced its ureter must of necessity follow an unusual course Thus with unilateral renal ectopia the ureter has to cross the midline in pelvic ectopia it is short and with horseshoe kidney the upper ends of both ureters are displaced forwards and lie unduly close to the spine These and other congenital displacements resulting from renal maldevelopment have already been described

DUPLICATION AND BIFIDITY OF THE URETER

Duplication and bifidity of a ureter are both very common In duplication two distinct channels are present from a single kidney to the bladder whilst in bifurcation the channels are separate above but unite at some point between the renal pelvis and the bladder Double and bifid ureters without exception are found to drain a duplicated pelvis A ureter bifid in its lower portion and single above is practically unknown though Rihmer has reported an authentic instance In each condition the two ureters run their courses in close proximity bound together in a common connective tissue sheath It is important to differentiate between a single kidney having two ureters of its own and the condition of unilateral fused kidney each component of which is served by a separate ureter In the latter the fused organ represents the glands of the two different sides which have ascended on the same side of the body and united (*see* page 385) It is presumed that duplication of the ureter results from a splitting of the original ureteric bud into two parts each of which forms its own pelvis and collecting tubules and claims its own quota of metanephric tissue

DUPLICATION OF THE URETER

Unilateral duplication of the ureter is frequently encountered as it occurs in about 2 or 3 per cent of bodies (Bostroem Pohlman et al)

The sexes are equally prone to the anomaly, and the right and left sides are affected in like proportions. Bilateral duplication is much

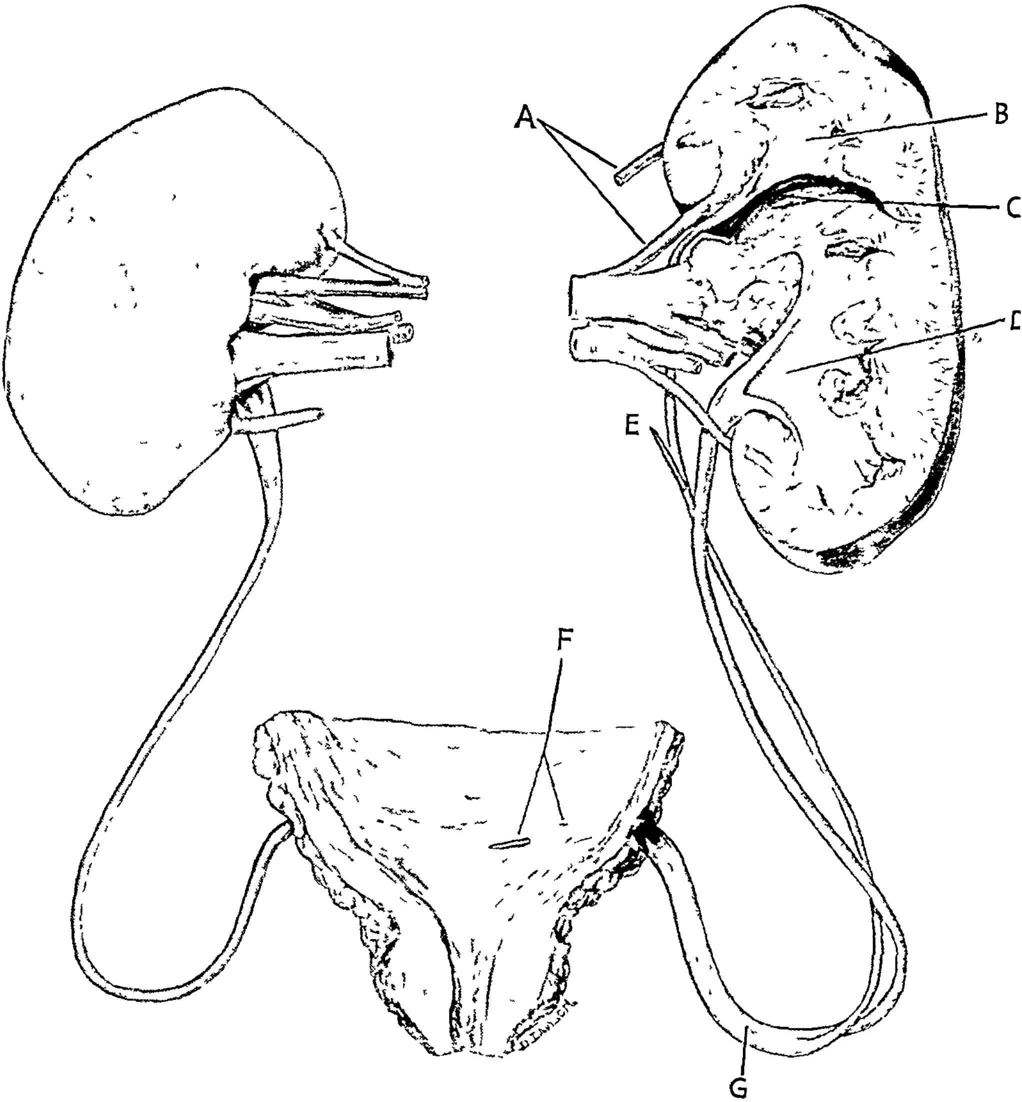


Fig 241 —Duplication of left pelvis and ureter —Note (1) Relative length of the two kidneys, (2) Sizes of respective pelves and ureters, (3) The deep sulcus between the two sections of the duplicated kidney each of which has its own capsule, (4) Separate blood-supply to the upper elements, (5) Crossings of the two ureters and the insertion of the ureter from the upper pelvis below and internal to its fellow A catheter has been introduced into the lower ureteric orifice and has been made to emerge through the wall of the ureter in its upper part The lower orifice drains the upper portion of the kidney, (6) Connective tissue sheath enclosing ureters which has been retained below but removed above, (7) The upper portion of the kidney is moulded over its fellow so that its under-surface is concave and its general outline semilunar The lower portion is reniform A, Separate vessels to upper segment, B, Upper pelvis, C, Dividing sulcus, D, Lower pelvis, E, Catheter, F, Two orifices (note emergence of catheter), G, Two ureters in common sheath

less frequent, but is not uncommon The author personally has seen multiple examples

There is much constancy in the anatomical arrangements Starting above there are two pelves which serve independent portions of the kidney (*Figs* 241–244 and 249) They are placed one above the other never one in front of the other The upper pelvis is the smaller and drains approximately a third of the kidney, the lower obviously the larger serving the remainder These proportions are singularly constant Exceptions have nevertheless been known, the two divisions having been equal in size whilst in two instances the

Fig 242

Fig 243

Figs 242, 243 —Duplication of ureter and pelvis The catheter in the ureter draining lower pelvis did not enter area of pyelogram This pelvis was distended first (*Fig* 242) and later the upper pelvis was filled through catheter which appears in the pyelogram (*Fig* 243) Note small size and rudimentary appearance of upper pelvis

upper was the larger The ureters are proportionate in size to their pelves Usually the upper pelvis shows two or three minor calices only and it appears to represent the upper major calix and associated minor calices of a kidney supplied with a single ureter whilst the lower pelvis which is larger and better fashioned corresponds to the middle and lower groups of calices The pelves never communicate The contrary has been affirmed by several writers almost certainly incorrectly and on embryological grounds it would appear improbable that they could communicate

Passing downwards we find that the ureters bear definite relations to each other The superior ureter at the upper end starts internal

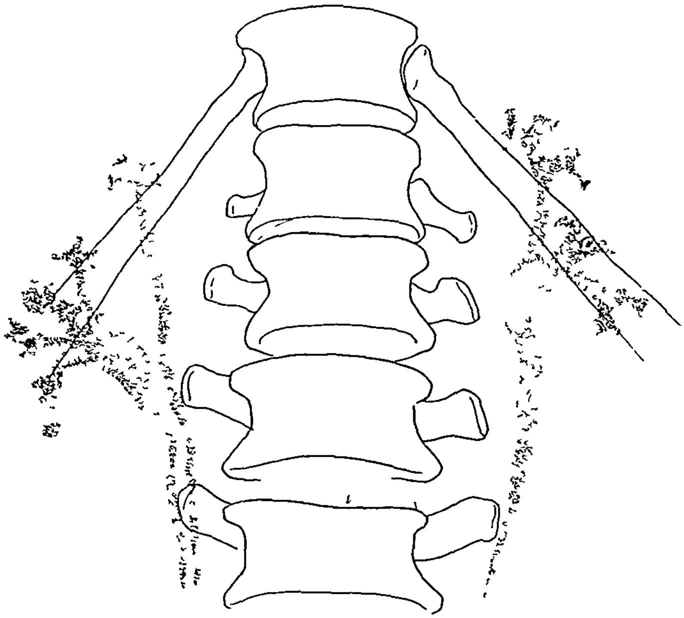


Fig 244—Right pelvis duplicated Upper segment very small Lower segment might pass for a complete, normal pelvis, though the upper calix is unduly short No concomitant disease or dilatation Normal left pelvis, but showing a tendency to bifidity, as is often the case when the other side is double

to its fellow, but soon passes behind it so as to become external In the lower third of its course to the bladder it again crosses posteriorly so as to regain the inner side (*Figs.* 241–249) This is true for the majority of ureters, but does not cover all cases A pyelogram is shown in *Fig* 245 in which the ureters run parallel courses without crossing, and Papin has illustrated a specimen in which the upper tube wound spirally round the lower.

Fig 245—Double ureter Note the absence of crossings

When the bladder is reached it is found that "the ureter of the upper half of a double organ opens (within or without the bladder) caudally and mesially to the ureter of the lower half" This law was formulated by Weigert in 1877 and was restated by Meyer in 1906 It is known on the Continent as the Weigert-Meyer Law It may be supplemented by the statement

that the ureter of the lower pelvis opens at the site which is correct for the normal single ureter The explanation of this relationship is given in *Fig* 246 where it will be seen that the lower ureter on the vas precedes its fellow during their migration towards their final insertion and that this precedence continues till the leading ureter wins home when progress by the second ureter ceases This law likewise is not without its exceptions (Perlmann Bostroem Nicolich et al) At their point of implantation I have known the two orifices to be so closely approximated that they appeared cystoscopically as a single opening and were only distinguishable by the double efflux rendered evident through chromocystoscopy For the most part however they will be found sufficiently far apart to be easily recognized The lower

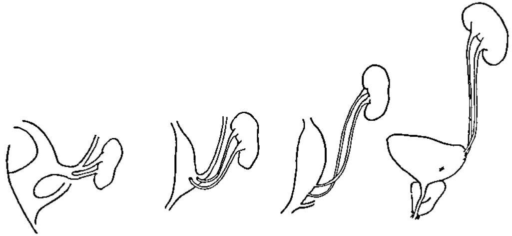


Fig 246 —To explain why the upper renal element receives the lower insertion at the bladder The origin from the Wolffian duct (*see* page 410) is seen and in the migration along that channel to reach that part of the cloaca which ultimately forms the bladder the ureter which was originally the lower one precedes its partner and thus eventually becomes the upper

opening may indeed be far removed in the direction of the bladder outlet or may open into the urethra or elsewhere Extravesical implantations *will be described later*

BIFID URETER

A bifid ureter (*Figs* 247 248) is one which when traced upwards from the bladder is found to divide at some point above the meatus and below the renal pelvis into two separate channels The point of this division is very variable It may be situated actually within the vesical wall or on the other hand so high up as to appear merely as an exaggeration of the bifid pelvis (Chapter XXV) Bifidity is said to be at least as common as duplication though precise figures are lacking It escapes notice at cystoscopy and at instrumental urography the catheter may pass up one branch which alone receives

the opaque medium, though frequently there is an overflow to the other channel. Excretion urography shows up many examples. Bifidity on one side may be associated with duplication on the other (*Fig* 249) Bifidity on both sides is extremely rare for Papin could find but 12 reported cases up to the year 1927. When the bifurcation takes place near the bladder the anatomical course and relationships of the two ureters, as also the formation of the two pelves, are identical with those described for duplication When the division is higher one or both of the ureteral crossings may be wanting, according to its position.

If the ureteric orifice is duplicated one tube may fail to reach the kidney and so ends as a cul-de-sac at a greater or less distance above the bladder. This is a suggested origin for a vesical diverticulum Similarly with ureteric bifurcation one of the channels may abort and it is then termed a *ureteric diverticulum* Such a diverticulum may house a calculus, and by this or other means may be a cause of obstruction to the functioning channel.

Fig 247 —Bifid ureters High junctions No other pathological condition

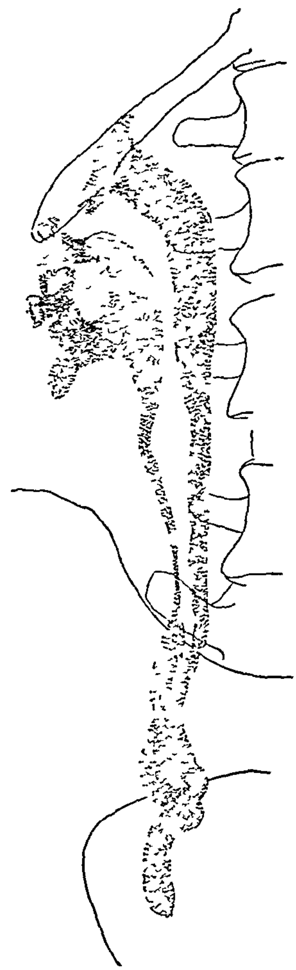


Fig. 248 —Bifid ureter Low junction All segments dilated

The outward appearance of the kidneys associated with duplication and bifidity of the ureter does not differ much from the normal, except that they tend to be somewhat longer Often no alteration

is observable externally. Sometimes a furrow is present indicating the boundaries of renal substance drained by the respective pelves. This furrow is stated to be most evident when the bifurcation is near to the kidney (Papin). On longitudinal section (*see Fig.* 241, page 402) the division is more apparent, each pelvis obviously having its own parenchyma. The two areas of parenchyma are, in many examples, partly separated by a double layer of capsule which insinuates itself between them like the pleura between two lobes of the lung. The position of the kidney is not affected by these structural variations. It almost invariably occupies its correct situation in the loin and its two pelves have rotated correctly so as to face the midline.

The blood vessels associated with these anomalies have not been carefully described but appear not to be grossly abnormal.

Fig. 249.—Duplication of the tract on the right side. The upper pelvis is somewhat ballooned. The long upper calyx and *almost complete absence of pelvis on the left side* constitute a transition between the *B* type of pelvis (pages 441–443) and true bifidity.

Associated anomalies occurring in the urinary organs are: (*a*) *Kidney*—defective development (hypoplasia, aplasia, agenesis), polycystic disease, renal ectopia (*see* page 410 et seq.), horseshoe kidney; (*b*) *Ureter*—ureterocele (*see* page 235), ectopia, stricture (especially of the lower ureter where it forms a junction with that from the upper pelvis). These are said to occur in about 10 per cent of cases, but the author has seen many ureteric duplications and bifidities but has certainly not seen so high a proportion of additional congenital anomalies.

Genital defects are unusual.

Diagnosis.—The diagnosis of duplication is self evident at cystoscopy in most cases for the second meatus lies somewhere near its fellow. When, however, the opening is far displaced, and especially when it is extravesical, it will be more easily overlooked. Both ureters must be catheterized and the urine examined. Urography will exhibit the contour of their respective pelves, displaying all the various features which have been above described. When the condition is bilateral, excretion urography offers advantages, especially in the male, as four catheterizations are difficult to manage and may prove distressing to the patient.

A bifid ureter cannot be recognized apart from urography, which may be either of the instrumental or intravenous variety With the latter it may be necessary to examine several plates before the picture can be pieced together owing to the fragmentary nature of the shadows and indeed excretion urography may fail or mislead owing to diminished function of one segment It does not reliably differentiate between a bifid and a duplicated ureter With instrumental urography the following possibilities are presented —

1 The catheter tip lies distal to the bifurcation and contrast fluid flows up each ureter.

2 The catheter passes beyond the bifurcation up one or other channel, generally selecting the larger one The fluid regurgitates down the occupied ureter and up the other one The presence of a catheter obstructing the lower ureter encourages regurgitation into the unoccupied tube, the distension of which, however, is often found to be poor.

3. Pyelography outlines a small obviously incomplete pelvis and attempts are made by withdrawal, or by withdrawal and reinsertion of the catheter to demonstrate another pelvis

Complications.—Kidneys with duplicated outlets are very susceptible to disease Robinson discovered hydro-ureter of one ureter in 24 per cent of 50 specimens of duplication, while Braasch and Scholl, reviewing 144 cases at the Mayo Clinic, showed that 54 per cent had definite pathological complications, including hydronephrosis, pyonephrosis, pyelonephritis, tubercle, and lithiasis Mertz, examining 300 reports, found disease in 80 cases (27 per cent) These included Obstruction with or without infection (*see Fig* 274, page 454), renal tuberculosis, renal (*Figs* 250–252) and ureteric lithiasis, and atrophic pyelonephritis One section of the kidney may be infected or otherwise diseased whilst the other escapes The two different parts will then be dissimilar in respect of (1) Normal urinary constituents, (2) Pathological contents of the urine (albumin, blood, organisms, etc), and (3) Functional capacity

Treatment.—Disease in these organs may be treated on general surgical principles The existence, however, of a double outlet and a separate blood-supply encourages an attempt at resection of the kidney when the disease is limited to one part, and a growing number of case reports of such procedures is available The kidney shown in *Fig* 252 has a double pelvis and ureter The lower portion is dilated, and contains a stone (*Figs* 250–252) Several large cysts are to be observed in the renal tissue It was resected In performing a division of the two portions care must be taken (1) To keep to the natural line of separation between the two portions, which is sometimes shown by a deep sulcus (*see Fig* 241), (2) To seal exposed tubules

with a cautery (3) To leave abundant capsule for overstitching, (4) To suture carefully otherwise a urinary fistula may form The kidney pouch should be drained

Fig 250

Fig 251

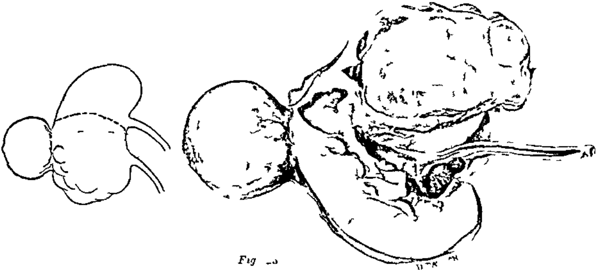


Fig 252

Figs 250–252.—Showing straight radiograph urogram and operation specimen and illustrating procedure in diagnosis Straight radiograph showed a single shadow very low down and externally placed Cystoscopy revealed two ureteric orifices on the right side Both were catheterized Note the course of the catheter to lower pelvis The urogram shows the double pelvis the distension of the lower segment and the blotting out of the stone shadow The whole kidney lies low At operation the lower component was removed as it was severely cystic *the line followed being that of the natural cleavage (see line drawing and Fig* 41 page 40.) The specimen is drawn from above (cut surface)

ERRORS OF IMPLANTATION OF THE URETER

The orifices of the ureter may be faultily inserted within or without the bladder Faulty insertions *within the bladder* have already been discussed They are associated : (1) With malformations of the kidney a good example being when the single ureter of a solitary kidney opens in the midline ; and (2) With duplication of the ureter. when. one of the orifices being normally situated. the other is displaced towards the vesical neck The majority of intravesical displacements are symptom-free and are. therefore, found unexpectedly at cystoscopy or in the cadaver.

Extravesical implantations are more important They are much commoner with double (*see* page 401) than with single ureters Hartmann (Leipzig) collected 16 cases of positive and 12 of doubtful supernumerary displacements as against 7 in which a single ureter was ectopic. With double ureters it is always the channel which originates from the upper pelvis (lower insertion at the vesical end—Weigert-Meyer Law) that is ectopic

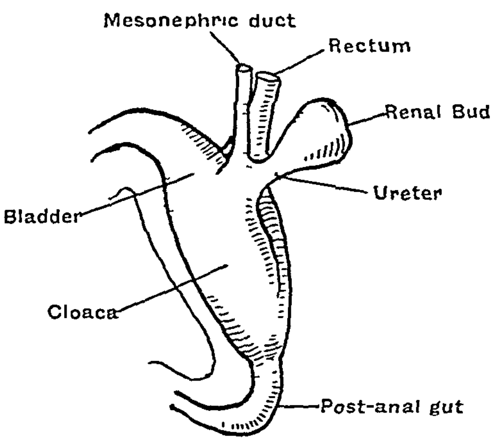


Fig 253 —To show the origin of the ureter from the mesonephric (Wolffian) duct (*After Keibel*)

It will be recalled that the ureter originates as an offshoot (*Fig.* 253) from the lower end of the Wolffian (mesonephric) duct (seminal duct duct of Gartner in the female) and that from this it migrates to the uro-genital sinus (sixth week). The two ducts then part company, the ureter passing forwards and upwards to that area which will ultimately form the trigonum vesicæ and the vas continuing downwards in the genital cord side by side with the Mullerian duct the two opening near each other (*Figs* 254. 256) All the various degrees of ectopia result from the ureter retaining its association with the parts from which it originated or along which it should migrate to reach its correct insertion—therefore —

1. In the *male* (*Fig* 254) it may open into the common ejaculatory duct the seminal vesicle (*Fig* 255). and occasionally into the last section of the vas deferens It may also open at the verumontanum If after its separation from the Wolffian duct it has failed to move sufficiently ventralwards towards the bladder its outlet will be found in the posterior urethra—always at or above the level of the verumontanum, never below it. and always on the floor In reaching this situation its course may pass between the bladder and prostate or

may traverse the latter In any of these abnormal situations but particularly when it opens into the seminal channels its orifice is prone to stricture formation The result then varies with the anatomical conditions If the ureter is a single one the whole of the urinary channels on that side are dilated If on the other hand it is one of duplicate ureters the upper and smaller pelvis alone is

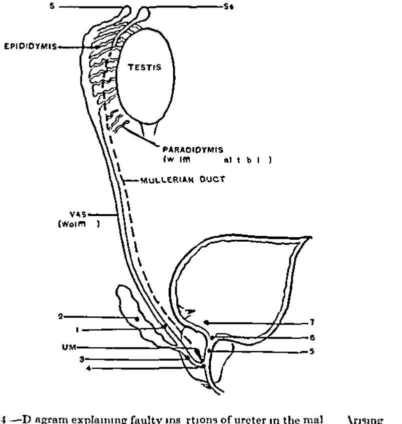


Fig 254 —Diagram explaining faulty insertions of ureter in the male Arising from the lower end of the Wolffian duct (*see Fig* 253) it may remain attached to 1 The vas 2 The seminal vesicle 3 The common ejaculatory duct 4 The junction of common ejaculatory duct and urethra at verumontanum 5 The floor of the posterior urethra above verumontanum 6 The internal meatus 7 The bar of Bell St Stalked hydatid of Morgagni—remnant of pronephros The Mullerian duct is represented by the utriculus masculinus (UM) and the sessile hydatid of Morgagni (Ss) The intermediate portion disappears and is indicated by a dotted line Compare *Fig* 256

involved Thom (1928) collected from the literature 61 examples of ureteric ectopia in men The prostatic urethra accepted the ureter 33 times the vesicle 17 times the vas 6 and the ejaculatory duct 5 Only 7 of these cases were diagnosed during life

2 In the *female* (*Fig* 256) the structures which are the homologues of those affected in the male may receive an ectopic ureter These are

the duct of Gartner,* the vagina, and the urethra. Hartmann (Copenhagen) states that the ureteric opening was found in the

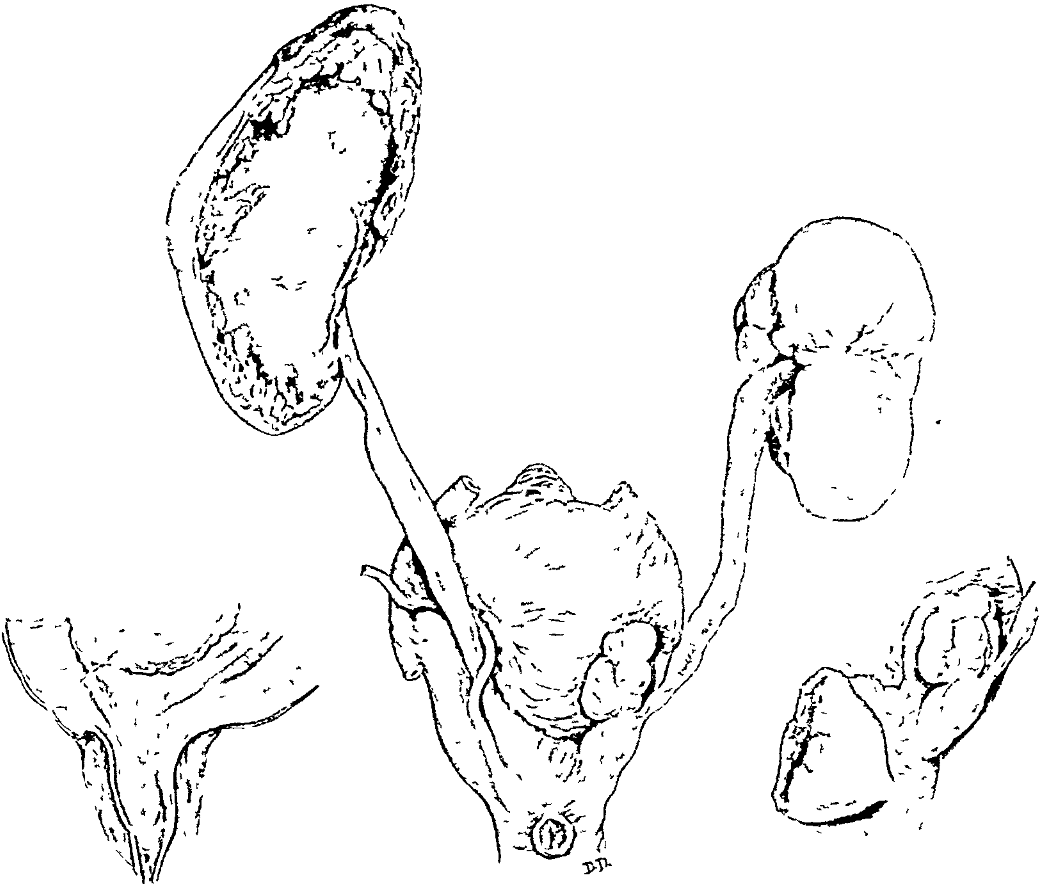


Fig 255 —Three views of parts removed from an infant who was the subject of several deformities

1 *Posterior aspect* (centre), note (*a*) Below—a rosette with a central depression where the rectum opened into the posterior urethra (*b*) The right ureter opens into the right seminal vesicle, which is dilated The corresponding kidney is hydronephrotic and cystic (*c*) There was no vas deferens on this side (*d*) The left ureter and vas deferens are inserted normally The vesicula seminalis of this side is not visible (? accidentally removed)

2 *Anterior view* Asymmetrical trigone showing normal insertion of the left ureter and an undeveloped right ala The dimple in the posterior urethra is the opening of the rectum

3 *Lateral view* before removal of funnel of rectum showing its attachment to the prostate, etc (*From specimen lent by the late E D McCrea*)

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* Gartner's duct (remnant of the Wolffian duct), with few exceptions, disappears in the human female but it persists in the sow, elephant, and other animals When it persists, it lies in the mesosalpinx and, reaching the cervix uteri, penetrates the latter superficially and continues down in the wall of the vagina to end near the duct of Bartholin in the vulval cleft We are thus presented with the odd circumstance that the remnant of the Wolffian duct lies embedded in the walls of

vestibule in 21 cases in the vagina in 8 in the duct of Gartner in 2 Thom (1928) collected from the literature 117 cases in women The

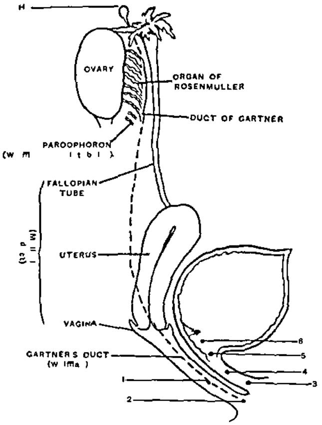

Fig 256 —Faulty insertions of ureter in the female The Mullerian duct is seen in this sex to develop into the Fallopian tube uterus and vagina The Wolffian duct from which the ureter originates becomes rudimentary Its remainders are the hydatid of Morgagni (Hy) found near the fimbriated end of the Fallopian tube and the vertical limb of the organ of Rosenmuller (in broad ligament) Portions below this disappear in the human—*see* dotted line Remnants are sometimes found in the lateral wall of the vagina where it is called the duct of Gartner The embryonic association of the ureter with this duct may persist and it is then found in the wall of the vagina (1 2) The line along which the ureter travels in its journey to the bladder is represented by the posterior wall of the urethra and the bar of Bell The opening may therefore be found at the external or internal urethral meatus (3 5) in the wall of the urethra (4) or on the bar of Bell (6) Compare *Fig* 254

urethra received the insertion 37 times the vagina 32 the vestibule 45 and the uterus 3 times In about 9 instances (Davis Mulholland

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structures which are derived from the Mullerian duct but this is easily understandable when the close embryological association of these two primitive channels is considered The ureteric bud arises from the lowest part of the Wolffian duct and so when ectopic rarely emerges as high as the cervix (Andrews collected 6 cases including a personal one in which the opening was near the cervix) The most common exit is at the vestibule

etc) the ureter in reaching the female urethra traversed the fibres of the internal sphincter By this muscle it was compressed except during micturition so that the patient was not incontinent In this way the accessory ureter was turned into an additional receptacle and underwent dilatation

Opening of the ureter into the rectum is a very rare phenomenon. It occurs when the Wolffian duct and ureter have failed to move before the rectum is split off from the urogenital sinus It is invariably associated with other gross developmental defects

Symptoms and Diagnosis.—In the *female* the symptoms are characteristic There is diurnal and nocturnal incontinence of urine to the extent of one-half or less of the total urinary output, whilst the remainder is periodically and normally evacuated The condition originates at birth but is not evident until bladder control has become established The underlying cause may go long unsuspected Continual urinary leakage causes excoriation of the skin of the vulva and thighs. The patients are keenly alive to the severe social disadvantages from which they suffer The supernumerary orifice requires a diligent search with a speculum and a good light as it is invariably small and hidden by folds of mucosa When it lies in the vagina a vaginal tampon and the intravenous injection of indigo-carmine may, if the function is adequate, assist in its identification When at the vulva, close and prolonged inspection is necessary or it will be overlooked The periodical appearance of a few drops of urine brought down by ureteric peristalsis will eventually betray its whereabouts Pressure over the flank or lower abdomen sometimes expels pus into the vagina and shows the situation of the outlet. Local pressure in the vagina itself may similarly milk down the contents of the ureter

Urinary leakage due to ectopia is very liable to be attributed to vesical incontinence from sphincteric weakness, which is much commoner A useful test distinguishing these two conditions in difficult cases is to introduce a coloured fluid—indigo-carmine, because of its rich colour, is the best—into the bladder A perineal pad will, in the case of ureteric ectopia, be moistened with urine free from carmine but in the case of vesical incontinence it will be stained

Whatever the position an attempt at catheterization should be made with a view to obtaining the separated urine, to renal function tests, and retrograde pyelography But catheterization may prove difficult or impossible owing to stenosis of the orifice * The urine from an ectopic ureter has a lower specific gravity than that from

* Campbell, reportin[illegible] in children, denies that the orifice is small, which is contrary to th[illegible] of most writers

the bladder and is deficient in the customary urinary salts. It is almost always infected though the degree of infection varies considerably, the fluid in some instances being mildly purulent, in others consisting of thick stinking pus. Renal function tests usually show poor function. If the catheter has been successfully passed a pyelogram of the associated pelvis will be obtained. Invariably it will give evidence of some grade of injury (*Fig* 257). The exhibition of the remainder of the urinary tree may advisedly be left to excretion urography, thereby avoiding the risk of spreading infection.

Excretion urography may precede or follow the discovery of an ectopic ureter. In the former event it may display the duplicated upper tract but the function of the involved renal segment is usually so low that the excretion of uroselectan, as of indigo carmine, more often than not fails. The lower component is well shown and as it mimics the normal quite closely it may be mistaken for a complete pelvis but to the practised eye it looks suspiciously rudimentary (cf *Figs* 244 and 249). In particular it is numerically short of calices and the substitute for the upper major calix is stunted. If the outline of the top of the kidney is clearly displayed it will be recognized that an abnormally large section of the upper pole is devoid of a drainage system.

Fig 5 —Ureteric ectopia. Orifice in the vestibule. Retrograde pyelogram of both pelves the lower being normal the upper only partially filled and showing evidence of severe back pressure.

In the *male* urinary incontinence does not occur as the ureter opens behind the external vesical sphincter the urine returning to the bladder through the weaker internal sphincter. The condition therefore escapes observation more readily than in the female. Many such ureters are almost certainly missed. An excretion urogram may show a double ureter extending to the bladder. The absence of a second orifice in the bladder on cystoscopy is not helpful because it is likely to be attributed to the fusion of the two channels *immediately before they enter the bladder* rather than to an ectopic ureter though the alternative explanation must be kept in mind. Urethroscopy is called for. The ureter has been catheterized through a posterior urethroscope. The condition

CHAPTER XXIV

RENAL FUNCTION TESTS

RENAL function tests are an integral part of the investigation of a patient and in many cases go on side by side with the cystoscopy, some of the most important of them actually depending on the cystoscopy for their performance Such tests may be applied to the function of the two kidneys taken together (total renal function) or to that of each of the kidneys individually (separate renal function) Speaking generally, the cystoscopist is more concerned with the function of the individual organ than with total function, though the latter also may have an important bearing on his final summing up. But he is usually dealing with disease primary in one kidney, and having discovered which is the affected organ, he next wishes to know the condition of its fellow, in view of the possibility of surgical intervention

Information about separate renal function is obtainable by excretion urography or by cystoscopy, but quite frequently both these examinations are carried out in the same patient and the answers are available for comparison and indeed generally give similar and confirmatory results A consideration of excretion urography will be deferred until Chapter XXVII Cystoscopic function testing takes two possible forms. (*a*) watching the outflow of dyestuffs at the ureteric orifices, and (*b*) with the aid of ureteric catheterization, collecting the secretions from the kidneys individually Before the days of excretion urography the cystoscopic methods were the only ones available for separate function tests and they remain exceedingly important

Selection of Tests for Renal Function.—A considerable number of tests have at one time or another been used, but most of them, after careful investigation in the past have been discarded The selection of a test will depend on its reliability and on its simplicity Reliability is the more important of these, but no test is reliable under all circumstances and in all cases, and the urologist should not confine himself to any one He should select two or three and not forsake them until he has acquired a mastery over their possibilities and failings and the methods of circumventing the latter Simplicity in the working of a test, though obviously second in importance to reliability, is nevertheless of much moment Complicated physical, chemical, and colorimetric tests are time-consuming, and cannot be

carried out alongside the cystoscopic examination. An unfortunate interval therefore occurs between the cystoscopy and the decision on a line of action during which specimens collected are put aside for personal examination or are sent to the laboratory for this purpose. It is a great advantage if the test is so simple that its result can be made known at the time of the cystoscopy and if its technique is not too laborious to be undertaken by the surgeon or his assistants whilst conducting a cystoscopic clinic.

When employed to estimate separate renal function most tests depend on the power of the kidney to excrete certain substances introduced into the body for the purpose of the test (excretion tests). This constitutes an artificial stimulus to renal activity and the vigour of the resulting response is the measure of the kidney's capacity.

EXCRETION TESTS

Significance of Excretion Tests.—Any substance used in excretion tests must be dealt with by the kidney in a manner similar to that which it employs in eliminating the waste products of the body. The activity of the kidney in dealing with such substances will then be representative of its excretory capacity in its ordinary work and will thus provide a true indication of its function. There are three sets of excretion tests in common use at the present time: (1) Those depending on the elimination of substances occurring in our normal metabolism. (2) The dye tests, and (3) Tests resulting from the excretion of contrast media (diodone, iodoxyl). Of the first one will be described, the urea concentration test; of the second two, the indigo carmine and the phenolsulphonephthalein tests; and the contrast media will be dealt with when describing their use in urography (Chapter XXVII).

Taking the dye tests first, Heidenhain's work on renal excretion and much of that of his successors concerns the elimination of indigo carmine by the kidney and is based on the visible demonstration of that dye in the renal cells. It is assumed in his work that the kidney adopts the same mechanism for eliminating indigo carmine as it does for excreting certain of the urinary constituents, and the same assumption is made when we use indigo carmine and other dyes in renal function testing. It is almost certain that this working hypothesis is sound and in practice the dye tests give reliable information concerning the renal function.

Nevertheless some workers prefer the urea excretion tests, partly on the grounds that this substance occurs in the normal excretory activity of the kidney. Again in the urea concentration test it is assumed that the speed and facility with which this substance is eliminated is representative of the kidney's capacity to remove the whole of that group of waste products of which urea is so important

a member. If this were not so, the test would be useless, for urea alone is not the cause of the chronic uræmic symptoms so often witnessed in urology; indeed, by itself it appears to have very little harmful effect, as shown by the fact that the blood-urea may be reduced by dietetic means to the normal, and yet the patient die of uræmia (MacLean). It is only one of a number of waste products which accumulate in the blood, but the ability or inability of the kidney to get rid of it is believed to represent the renal efficiency in dealing also with other members of this group. It is selected for a test because its presence is easily recognized and its quantity easily measured.

THE UREA-CONCENTRATION TEST

The urea-concentration test was reintroduced and popularized by MacLean and de Wesselow during the first world war, its original purpose being the estimation of renal function in nephritis. Its use has been extended to the surgical field, including separate renal function.

Technique of the Test.—All fluid is withheld from the patient for eight or ten hours prior to the examination. After this he receives by mouth 15 g. of urea dissolved in 100 c.c. of water. The head of blood-urea thus artificially created is eliminated in health by the kidney within a few hours, during which time the urea in the urine is found to be in the neighbourhood of 2 to 2.5 per cent. Inefficient organs are incapable of eliminating urea in such quantities. If 2 per cent or more of urea is discovered in the urine, the kidney may be regarded as functioning well. When the figure is decidedly below 2 per cent the kidneys are not likely to be efficient, and when the result is between 1.5 and 1 per cent or lower, it is certain that a considerable defect exists.

Urea is a diuretic, and one of the first effects of the artificial head of urea is a marked diuresis. In the first and perhaps in the second hour this is so considerable as materially to affect the percentage reading for all urinary solids. The quantity of urea may therefore be well below 2 per cent in spite of a satisfactory elimination. The first hour's readings are therefore ignored, either the second or the third hour being found to provide the highest figure.

When separate renal function is being estimated the ureters are catheterized during the second or third hours after the administration of the draught of urea. Only a sufficient quantity of fluid is collected for the estimation of the percentage of urea, and the catheters are then removed. Meanwhile the total quantity of fluid excreted by the kidney during the separate hours is observed, and if this exceeds 130 c.c. to the hour, allowance must be made for the dilution, or the test must be repeated.

Diuresis is a weak point in this test. The urea percentage obviously depends on two factors, the quantity of the salt and the quantity of the solvent. To obtain satisfactory results from the percentage estimation, the latter of these should remain constant. Unfortunately it exhibits considerable variations, which cannot be controlled and for which compensatory corrections cannot be made. This factor has been taken into account by Swift Joly in work on total renal function. He considers that if the hourly response is 10 per cent of the administered dose the condition is satisfactory even though a copious diuresis brings down the percentage of urea. If one tenth (1.5 g.) is eliminated in each hour the patient appears to be safe so far as the kidney is concerned, whereas a 2 per cent urea excretion combined with a small elimination of water may occur in spite of renal inadequacy. Swift Joly considers that the following figures represent a perfectly satisfactory test:—

	Quantity of Urine	*Percentage of Urea*	*Quantity of Urea*
2nd hour	165 c.c.	1.3	2.1 g.
3rd hour	125 c.c.	1.6	1.9 g.

Whereas the following is distinctly bad:—

	Quantity of Urine	*Percentage of Urea*	*Quantity of Urea*
2nd hour	75 c.c.	1.7	1.27 g.
3rd hour	65 c.c.	2.0	1.3 g.

The application of the principle to separated catheter specimens is liable to fallacy because of the loss of fluid around the catheters, and it is time-consuming and requires prolonged ureteric catheterization.

When the urea concentration examinations are used for total renal function in prostatic surgery the highest readings are sometimes noted in the second and sometimes in the third hour of elimination. The same factors must obtain in separate renal estimations, and when the catheters have been in position for only a limited time there is no guarantee that this corresponds with the period of most copious elimination. If it happened to be a period in which excretion was poor, a faulty impression of the kidney's capabilities would be produced.

When one kidney is diseased or destroyed and the work of the body is being carried on unaided by the second organ, the writer has found a greater concentration of urea to be produced by this organ than occurs from either of two healthy kidneys when they are sharing the work.

The test is quite simple to work, the urea percentage being easily arrived at by any of the recognized variations of the hypobromite method, and it has been very popular in this country. In spite of the disadvantages of diuresis to which reference has been made, it is a delicate test. It should be routinely checked by blood urea

estimation, the sample of the blood being best taken for this purpose immediately before the administration of the dose of urea This additional examination is done in order to obviate the fallacy arising when a high 'pressure head' of blood-urea, itself due to advanced renal disease, causes a normal or even more than normal quantity of urea to escape through the damaged kidney from the accumulation in the blood The high percentage of urea registered by the concentration test under these circumstances would be regarded as evidence of good renal efficiency, had not its true cause been revealed by examination of the blood-urea

DYE OR COLOUR TESTS

Of these a number have been employed, but only two hold the field to-day, these are (1) *The indigo-carmine*, and (2) *The phenolsulphonephthalein tests* The former is the more popular in this country, the latter in America

I THE INDIGO-CARMINE TEST

Indigo-carmine was used by Heidenhain in his classical work on the physiology of the kidney as long ago as 1874, and was adopted for renal function testing by Voelcker and Joseph in 1903. The dye was at first administered intramuscularly, but not until it was used intravenously did the test become popular

Physical and Chemical Properties.—Indigo-carmine is the sodium salt of indigodisulphonic acid ($H_2C_{16}H_8N_2O_2(SO_3)_2$) It is a stable body and resists sterilization by boiling Its reaction is neutral, and on the addition of an alkali it turns to a pale yellow, its characteristic colour being restored on the addition of acetic acid A urine of marked alkalinity may occasionally decolorize the indigo in its passage through an infected kidney (Kidd), but this is very uncommon Decolorization might be a source of error, and the reason for the absence of blue would probably be overlooked The colour could be restored by the addition of acetic acid if the cause were recognized Indigo-carmine deteriorates if exposed to the air, taking on a greenish coloration, and should then be discarded as it is valueless It is now marketed in sealed ampoules which retain their quality indefinitely

Technique of the Test.—Indigo-carmine is generally used as a 0 4 per cent solution It is soluble up to 0 8 per cent Above this strength it is no longer a solution, but forms a suspension, and when given intravenously is dangerous, because the suspended particles may act as minute emboli Shock, dizziness, and pallor have been recorded as resulting from its use at too great strengths In two patients of mine a 4 per cent solution was used by mistake In addition to some slight vomiting, the skin—especially around the eyes and over the scrotum—became a bright indigo blue. One of the patients also

suffered from transitory convulsions due doubtless to minute emboli of undissolved dye lodging in the cerebral capillaries

Method of Injection—A 10 c c syringe preferably with an eccentric nipple is filled with the solution It must contain no air The median basilic or other convenient vein at the bend of the elbow (*Fig* 259) is usually selected to receive the dye the skin being sterilized with iodine In order to make the veins prominent the arm is held in a dependent position and a light rubber tourniquet—a rubber catheter answers the purpose very well—encircles the upper arm The patient is also instructed to clench his fist tightly The needle first perforates the skin to one side of the vein and then by a second movement the vein is entered The catheter which is fixed with a single hitch as shown in *Fig* 259 is now gently released avoiding movement of the arm which might disturb the needle lying in the vein 7 to 10 c c are used for adults and lesser quantities for younger subjects

When the vessel is of good size its lumen is easily found but when small or deeply situated it may be difficult to strike If the indigo carmine escapes into the subcutaneous tissues a small painful swelling appears around the tip of the needle A fresh point on the vein or another vein must then be selected and the manœuvre repeated Sometimes a suitable vessel cannot be found even though both arms are inspected This difficulty occurs most frequently in women owing to the greater development of subcutaneous fat Other veins may then be sought for in the thigh leg or neck but are usually even less suitable than that at the bend of the elbow

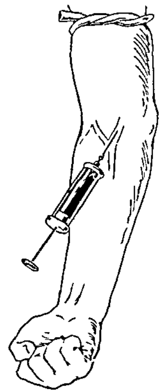


Fig 259 —Injection of indigo carmine into a vein

Recourse must then be had to intramuscular injection When used intramuscularly a larger quantity of dye (20 c c) must be employed in order to get comparable results The excretion then commences late (ten minutes) reaches its zenith in twenty minutes to half an hour and continues for several hours (up to ten)

Fate of Indigo carmine in the Body—About 25 to 30 per cent of indigo carmine can be discovered in the urine by colorimetric methods Of the remainder some is excreted by the liver and is found in the fæces as a leuco derivative which becomes blue on exposure to the air The fate of the remainder is unknown

In the urine the dye is observed in about 3 to 6 minutes in health, $3\frac{1}{2}$ to 4 minutes being the usual time Three-fifths of the total quantity eliminated by the kidneys is excreted in the first 15 minutes following its appearance in the urine, the depth of coloration increasing rapidly—almost suddenly—after its first onset During the next half-hour the greater part of the remaining two-fifths is excreted, though traces are still visible at the end of the second hour, and occasionally also at the end of the third There are two ways of noting the appearance of the blue, the one by inspection of the ureteric meatus (chromocystoscopy), the other by obtaining ureteric catheter specimens The latter, however, is little used

Chromocystoscopy is a very simple yet striking examination (*Plate XIV* D, page 368) The first sign of blue generally occurs as a faint puff from the ureteric orifice, but almost immediately the quantity increases, a copious and richly coloured efflux being shot into the bladder medium, and quickly diffusing itself there The cystoscopic field is momentarily clouded and then slowly clears again When this has been repeated several times the vesical fluid becomes so deeply stained with the dye that visibility is impaired

The meatus first inspected should be that one corresponding to the supposed healthy kidney, and as soon as one or two jets of blue have been watched and it has been decided that the work of that organ is satisfactory, the cystoscope should be turned to examine the other meatus If this kidney is seriously damaged, the excretion will be late and feeble Often it happens that before any blue arrives at this orifice the transparency of the vesical fluid has been interfered with by the dye pouring from the healthy side, and the lotion has to be changed This may happen several times during the cystoscopy, and at the end of twelve or fifteen minutes the investigation is abandoned with the note "No dye seen from the side in fifteen minutes" Frequently when watching an inactive meatus a swirl of blue from the opposite healthy kidney crosses the field, and may make the beginner, and sometimes even the experienced worker, wonder whether he has overlooked an emission of indigo from the meatus that is under observation

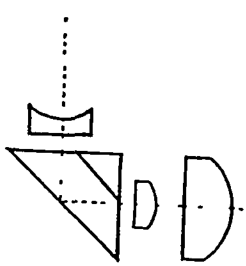


Fig 260 —Wide angle objective by means of which the two ureters may be simultaneously watched

To include both ureters in a single cystoscopic field for simultaneous observation a wide-angle objective (*Fig* 260) has been designed and is incorporated in the Bernard Ward catheterizing cystoscope With this instrument the two ureters may be kept in view at a standard focal distance of one inch, and the watch for blue is simplified

The points to be noted with the indigo carmine test are the time of onset of the elimination and the depth of the coloration when the dye is being actively excreted Should the first excretion occur early, say in 4 minutes the kidney may be regarded as of good capacity A 3 minute onset is by no means rare If the interval exceeds 7 minutes suspicion is cast on the kidney If it is over 5 minutes this delay should be counterbalanced by deep coloration when the peak elimination is reached otherwise the kidney should be regarded with distrust It is said that a copious diuresis may weaken the coloration of the dye but I have not found this to be so and do not think that even extreme excess in the output of water could be sufficient to affect its coloration materially If as sometimes happens only a part of the indigo has been introduced into the vein allowance for this circumstance must be made as the dye may appear late This may produce uncertainty in the surgeon s mind, in which event the investigation should be repeated

This test is very simple and can be undertaken at a moment s notice during an examination cystoscopy It is the quickest and least troublesome of all the tests the results being available as soon as the dye is excreted and that without the assistance of ureteral catheterization or chemical or colorimetric tests In dispensing with ureteric catheterization it saves time and also avoids such faulty readings as occur from leakage around the catheter or blocking of its lumen whilst it circumvents the secreto inhibitory action of the ureteric catheter which has already been discussed

The writer has employed the test extensively and in his experience it is one of the most delicate of all the tests It has been found to indicate minor disturbances of renal function very faithfully Thomson Walker however says that he has not found it reliable for minor degrees of inefficiency The test is a purely qualitative one and makes no pretensions to being quantitative Its popularity is high in this country In Germany Rehn sent a questionnaire to 33 clinics inquiring their preference in the matter of renal function tests He found that indigo carmine was used routinely in 32 out of the 33 clinics and that no other test was used more than half as often The next in popularity were cryoscopy of the blood and the experimental polyuria tests

II THE PHENOLSULPHONEPHTHALEIN TEST

This test was introduced by Rowntree and Geraghty in 1910 and is much used in America Phenolsulphonephthalein is a bright red crystalline powder first introduced by Remsen and soluble in water and more so in alcohol It is very stable and is not decomposed by boiling An alkaline solution has a brilliant red colour and its recognition in the urine depends on this fact

Technique of the Test.—Twenty minutes before the injection of the drug the patient drinks 300 c.c. of water in order to procure an active diuresis: otherwise delay in the excretion of the phthalein may be due to lack of renal secretion. One or both ureters are catheterized according to the requirements of the case, and then 6 mg. of the drug are administered in 2 c.c. of solution by intramuscular or intravenous injection.*

The secretion from the two kidneys is separately collected in two test-tubes labelled 'right' and 'left' respectively. Each of these contains one or two drops of a 25 per cent. solution of sodium hydroxide. As soon as the phthalein appears a pinkish tinge is observed in this solution, and the time is noted. In an acid solution the colour displayed is yellow or orange, in a strongly alkaline solution it is a brilliant purple-red. When the quantity of urine in the test-tube increases, fresh sodium hydroxide is added to render it markedly alkaline in order that the colour may be maintained. It is claimed that the dye is absolutely non-toxic to the body, that, though it occurs in the bile in high concentration after one or two hours, it is entirely reabsorbed, and is ultimately completely excreted by the kidney unchanged. It is non-injurious to the kidney. It takes about ten minutes on the average for the dye to appear in the test-tube when the kidneys are healthy, though sometimes this interval is considerably reduced. If given intravenously it generally appears much sooner—$1\frac{3}{4}$ to 4 minutes.

When phenolsulphonephthalein is used in the estimation of total renal function the test is a quantitative one. The urines excreted to the end of the first and second hours are diluted up to one litre and compared colorimetrically with a standard solution of phthalein in a Duboscq colorimeter. The total quantity of fluid excreted by the kidneys in this test does not matter, as the specimen has to be further diluted before examination. The quantity of dye excreted in the first hour in health is between 40 and 60 per cent. of the quantity injected, and in the second hour 20 to 25 per cent., making a total of 60 to 85 per cent. for the two hours. When the urine is separately collected from each kidney the proportion of work done by each individually may, under favourable conditions, be arrived at (*see*, however, below). It may, under these circumstances, be advisable to adopt a lesser dilution of the urine in the colorimeter, water being added up to a half instead of one litre. Absence of leakage along the

* The solution is made as follows: 0.6 g. of phthalein and 0.84 c.c. of 2N NaOH are made up to 100 c.c. by the addition of 0.75 per cent. solution of NaCl. A few drops of 2N NaOH are added until the maximum red coloration is developed. The drug is nowadays obtainable ready put up in ampoules of 1 c.c. capacity, each ampoule containing the requisite dose—6 mg. of the dye.

side of the ureteric catheters must be proved by catheterization of the bladder

The test is not an easy one in practice, and it has not achieved much popularity in this country partly owing to the difficulty in ensuring that the drug is of good quality Prior to the discussion on renal function tests at the Royal Society of Medicine in 1921, the writer used this dye extensively for a period of eighteen months and at that meeting reported that "it had given fair results" Its chief disadvantages were "The delicacy of the colouring and therefore the ease with which it can be vitiated by the presence of blood and pus particularly the former, a very small quantity of which will make a considerable difference in reading off on the colorimeter In many cases it is impossible to avoid a little hæmorrhage from ureteric catheterization When this has occurred I have resorted to the use of indigo carmine on a subsequent occasion, the difference in colour of this dye appearing to me to give greater security against a repetition of the failure *

The second difficulty is that of obtaining a true reading on the colorimeter I occasionally take several observations only to find that they vary and have seen readings by several different observers in which there has been a considerable discrepancy '

Though the phthalein test aims at being a quantitative one when applied to total renal function a similar claim cannot be made for separate renal function unless the catheters are kept in position for a sufficiently long time to collect all the dye which is undesirable, and also because a quantity of urine is generally lost alongside the catheter and finds its way into the bladder A further disadvantage is that one solution used in the colorimeter contains urinary pigments whilst the other is made up with water An attempt to get over this by diluting the standard solution with urine is only partially successful owing to the wide variations in the coloration of that fluid

Petersen has employed the indigo carmine and phthalein tests consecutively in the same patients After catheterization of the ureters he injects the standard dose of carmine and watches its onset and peak period At the end of about half an hour only a small quantity of the dye is being excreted He now injects a standard dose of phthalein and this is received as usual into a test tube containing sodium hydroxide The alkali simultaneously develops the coloration of the phthalein and decolorizes the remnants of the carmine The behaviour of the two drugs can thus be separately observed

* Marrick however states that blood can be removed by precipitation with zinc chloride

EXCRETION UROGRAPHY

There are several ways of employing excretion urography to determine the function of the kidney, and these are described in Chapter XXVII, page 498

RETENTION TEST: THE BLOOD-UREA TEST

This test is really one of total renal function but it has two uses in the examination of the individual functions of the kidney (1) In the eliminating of fallacies associated with the urea-concentration test, which use has already been described, (2) In severe vesical disease accompanying a renal lesion (tuberculosis is a good example) the state of the bladder may be such as to preclude cystoscopy If it is demonstrable as the result of clinical examination, radiologically or otherwise that one kidney is totally disorganized the blood-urea test may be taken as an index of the work of the remaining kidney, and nephrectomy should be safe Excretion urography, however, provides a test which is usually trustworthy, and is of easier application in these circumstances

VALUE OF SEPARATE RENAL FUNCTION TESTS

General points to be taken into account in estimating the value of separate renal function tests are (1) *The variation in the amount of the excretion*, (2) *The reserve power of the kidney*, (3) *Sepsis*

1. Variation in the Amount of Excretion.—The quantity of dye or urea excreted by a *sound* kidney varies *inversely* with —

a The amount of work which is being performed by the opposite kidney This point has already been brought out in discussing the urea-concentration test A kidney which is doing the whole excretory work of the body eliminates urea or a dye in greater concentration than would be the case if the other organ were sharing the excretion

b The amount of reflex and toxic depression which has been caused by disease in the primarily affected kidney In the section on albuminuria (page 372) it was shown that serious disease of one kidney may cause parenchymatous nephritis in the other This is probably of threefold origin It arises owing to increased strain being thrown on to it, to the necessity for excreting toxins produced by the neighbouring gland and is possibly also partly reflex in origin As a result of this sympathetic nephritis casts and albumin are discoverable in the catheter urine from this otherwise healthy kidney In suppurative conditions waxy disease may be superadded As a rule this kidney improves following the removal of its diseased fellow, as is shown by the disappearance of the albumin and casts from the urine But on occasion it proves inadequate by itself for the work of the body, the

work of its fellow though perhaps inconsiderable having previously augmented it sufficiently to ward off uræmia

Excretion will vary *directly* with the extent to which compensatory hypertrophy has taken place in the sound kidney This constitutes a difficult problem in urinary surgery As shown by Rose Bradford man is supplied with approximately three times as much renal parenchyma as would meet his minimum requirements The extra two thirds constitute a safety margin of tissue When one kidney is partly destroyed the organism attempts to make good the loss by hypertrophy This occurs chiefly in the opposite kidney but it also occurs under favourable circumstances in the diseased one Thus Guyon and Albarran showed compensatory hypertrophy in the wall of hydronephrotic sacs and the latter in a pyonephrosis and also in the remaining portion of a kidney containing a malignant growth An attempt appears to be made by nature to restore the previous standards but it may fall short especially where the supposed healthy organ is diseased prior to or as a consequence of the disease in its fellow The extent to which nature has already made this reserve good is difficult to assess

2 Reserve Power of the Kidney—No tests are available to indicate the reserve power of the kidney though Albarran by means of his experimental polyuria test comes the nearest to furnishing such a guide The test is briefly as follows —

The ureters are catheterized and the urine is collected from each kidney for half an hour in order to find the measure of their normal output Three large glasses of plain water or Evian water are now taken and the collection of urine is continued for a further one and a half hours The receivers for the urine are changed at equal intervals and the quantity of urine is measured for each unit of time A comparison is thus possible between the output of the kidney when resting and under conditions of forced diuresis A healthy kidney can react with great vigour eliminating during forced diuresis as much as six times the amount of its previous output during rest A comparatively inefficient kidney prior to the draught of water may be producing a greater quantity of urine than the healthy one but when the extra appeal is made it is incapable of responding It continues to plod along with little or no augmentation of output When plotted out as graphs the differences between the reaction of an inefficient and an efficient kidney are very striking

Together with Guyon Albarran formulated the following two laws A diseased kidney has a more constant function than a healthy one and the greater the destruction of its parenchyma the less does its function vary from one minute to another The second law is a corollary to the first As the result of any passing stimulus

whatsoever to the renal function, the increased renal activity which results therefrom is always more marked on the healthy than on the diseased side" According to these laws we see that the function of the kidneys should not be estimated only when they are working under ordinary circumstances for then a diseased organ may hide its deficiency by the constancy of its output But if they are examined under provocation by means of forced intake of fluids, the healthy kidney can react energetically whilst the kidney which is without reserve responds feebly or not at all, as it is already working to its fullest capacity This test applied to the supposed healthy kidney comes nearer to indicating its reserve of power than any other

Another problem is the extent to which further hypertrophy will occur If a kidney has been totally destroyed for some considerable time, it is a reasonable presumption that the opposite organ has had sufficient time to produce as much hypertrophy as it is capable of It may have been hampered, however, by the incubus of its diseased neighbour, and when freed from the latter it tends to recover from the parenchymatous nephritis from which it may be suffering Tuffier states that in parenchymatous nephritis no hypertrophy occurs We have seen that the evidences of this lesion generally disappear when its diseased fellow is removed, and it is reasonable to hope that the kidney will then undergo hypertrophy Some degree of interstitial change may, however, have taken place and will prevent recovery

3 **Sepsis.**—Sepsis, if existing in a kidney at the time of the test, will be recognizable and will impoverish its function On the other hand, it may be implanted subsequently When a kidney which has given good tests later appears by its behaviour not to bear out those tests, the possibility of sepsis being the cause should be remembered

Valuable as are these tests, they must not be allowed to assume too important a position The clinical features of the case must always be given their full weight, and the renal function tests must be considered alongside them All the evidence must be carefully assessed preferably by one accustomed to its interpretation and conversant with the scope and limitations of the tests

UROGRAPHY

The term 'urography' is used for the radiographical demonstration of any part of the urinary tract after opaque media have been used to render those parts more opaque Pyelography and ureterography indicate the same process when limited to the pelvis and ureter respectively though the former word is often loosely applied to both these procedures Cystography and urethrography refer to similar studies of the bladder and urethra Various uses of urography have been described in preceding chapters of this book The following chapters are concerned with pyelography and ureterography only— that is with the urography of the upper urinary tract Up to the year 1929 when excretion urography became a practical proposition urography was possible only by filling the tract from below with a solution opaque to the X rays In 1929 the advent of descending, intravenous or excretion urography provided an alternative method Separate chapters will be devoted to these two processes which though they have much in common yet present many points of difference

CHAPTER XXV

INSTRUMENTAL PYELOGRAPHY AND URETEROGRAPHY *

INSTRUMENTAL pyelography and ureterography are names given to the radiographic demonstration of the renal pelvis and ureter respectively, after filling them through a ureteric catheter with a solution opaque to the X rays This examination has many uses giving information about the shape and position of the pelvis and ureter which is invaluable in diagnosis The first pyelogram was accidentally made by Voelcker and von Lichtenberg in 1906 who when practising cystography with collargol found that the fluid had regurgitated up the ureter and outlined that structure and the pelvis of the kidney Klose however had attempted pyelography in 1904 using a bismuth solution He failed because his solution was too viscid The value of the method was not recognized until about 1910 since when it has received increasing attention Its use to day is universal and it may be stated that in the absence of proper facilities for urography the standards demanded by modern urology cannot be attained

DATA SUPPLIED BY PYELOGRAPHY

The data derivable from pyelography may be classified under the following headings (1) Demonstration that the pelvic outline is normal in shape and position (2) Detection of congenital abnormality in the upper urinary tract (3) Detection of alteration in the shape of the pelvis (4) Detection of alteration in the position of the pelvis (5) Demonstration of the relationship of the urinary tract to shadows seen on a previous radiograph

1 Frequently patients consult a surgeon complaining of symptoms the anatomical origin of which is difficult to locate but in whom the urinary tract is regarded as the probable site of origin The general examination together with radiographs and urinalysis however show no indication of urinary trouble There remains the possibility of pelvic distension or displacement as an explanation for the symptoms These can be excluded by pyelography and this will be the final link in the chain of evidence absolving the urinary tract

* *Synonyms* Cystoscopic retrograde ascending distension or infusion } { urography / pyelography

2 Congenital abnormality is often discovered quite unexpectedly by urography Its features and importance have been discussed in Chapter XXIII

3 Alterations in the outline of the pelvis may be due to :—

a Mechanical distension from obstruction at the ureteropelvic junction or elsewhere The cause may be intrinsic or extrinsic

b An *atonic dilatation* of the pelvis and/or ureter This may result from inflammatory causes (simple or tuberculous infections), or may be an expression of neuro-muscular dysfunction

c Cavitation of the renal parenchyma whether due to simple or tuberculous inflammatory processes or to necrosis occurring in a neoplasm (The cavities in all cases must communicate with the pelvis in order that the solution may reach them)

d Encroachment on the pelvis by tumours and cysts of renal or pelvic origin. or by foreign substances particularly stones blood-clot, or pus occupying the cavity.

e Pressure on, or *invasion* of, the cavity by neighbouring tumours or other swellings

4 The position of the pelvis may be altered when it is congenitally displaced. when it is abnormally mobile or when it is pushed aside by growths or other swellings arising within or without the kidney If the differential diagnosis between these various conditions cannot be made apart from pyelography. it is generally possible with the aid of that examination

5 A shadow in the neighbourhood of the kidney may result from some extramural opacity. such as a calcified tuberculous gland, gall-stone. etc It may be shown by pyelography to be separate from the urinary tract or if at first the two shadows coincide they may be divorced by altering the angle of the X-ray tube Shadows arising from opacities within the pelvis or ureter become partially or completely lost in the shadow of fluid contained in those channels, whilst if in the parenchyma they will have their relationship to the pelvic shadow exhibited

TECHNIQUE OF ASCENDING UROGRAPHY

It is highly desirable that the ureteric catheterization should be carried out on the X-ray table in order to avoid unnecessary movement of the patient and loss of time The operation which is time-consuming requires the willing co-operation of surgeon and radiologist if good results are to be obtained The patient comes prepared for X-ray examination in the usual way. The preparation of the bowel is, however. not of very great importance for the strong shadows thrown by the shadow-casting media can generally be easily distinguished from gas in the bowel. The details of the ureteric catheterization

are performed as described in Chapter XX. It is customary to employ a small ureteric catheter, one not larger than a No. 5, as an additional precaution against over-distension of the renal pelvis, so that the fluid may easily escape along the side of the catheter (*See* however page 526). In doing this the fluid outlines the ureter, producing a ureterogram. In all instances the catheter should be an opaque one so that its position can be observed.

The instrument is passed up to the pelvis of the kidney when possible. If, however, some obstruction prevents this, the pyelogram can still be obtained, especially if the buttocks are raised to encourage gravitation of the solution towards the kidney. In order to eliminate delay the radiographic apparatus is in absolute readiness before the injection is made. The solution will thus remain in the kidney for a short time only. The surgeon himself should make the injection; it must not be left in the hands of a junior, as too often occurs. He should also await the development of the films to decide whether or not they are satisfactory and whether it is desirable to increase the distension of the pelvis. Only by personal attention will proper filling and reliable data be obtained. A belt for abdominal pressure is usually employed in renal radiography, but is dispensed with in pyelography, first because it tends to empty the kidney of pyelographic solution, and secondly because it increases the intrarenal pressure. The patient lies prone, but in cases where the catheter has failed to reach the pelvis the end of the table or the buttocks are raised. In cases of mobile kidney a subsequent film may be exposed with the patient upright. When feasible this should be done by means of an adjustable table so that movement on the part of the patient is unnecessary.

Instrumental urography is to-day routinely performed on out-patients with no important ill effects, but provision is made for the patient to rest awhile in the event of there being any reaction. Such reactions are observed occasionally, but are usually transitory and of no lasting consequence.

Anæsthesia.—As the sensations of the patient are the best guide to when the danger point has been reached, it is obvious that general anæsthesia must not be employed, though sacral, low spinal, or local anæsthesia may be used for the bladder and urethra. A further reason for not employing general anæsthesia is that the patient must hold his breath during the taking of the radiograph, as otherwise the images will be blurred. In children general anæsthesia may be necessary. It will then be best to employ the gravity method for pelvic distension (*see* page 438) and to expose films frequently. Pain should be inconsiderable, but if it is complained of, a hypodermic injection of morphine may be given.

Solutions Employed.—The ideal solution for pyelography has yet to be discovered A large variety has at one time or another been tried most of which have now been given up as unsuitable Colloidal silver was the first to be used, and continued in favour for some time Silver oxide nargol and other silver salts were then tried and silver iodide became popular for a period At the present time sodium bromide and sodium iodide between them hold the field though the latter is deservedly the more popular.

An ideal medium must be innocuous, non-irritating non-viscid, of osmotic pressure similar to that of the urine, easily sterilized and of good opacity Sodium iodide is used at a strength of 13 5 per cent: sodium bromide at 15 to 25 per cent 20 per cent being generally adopted Sodium bromide was introduced by Weld as a pyelographic medium in 1918, and sodium iodide was employed by Cameron about the same time The potassium salts were at first used interchangeably with the sodium salts, until it was demonstrated by Weld that pyelographic solutions are absorbed freely from the renal pelvis (*see also* Chapter XXVI) especially when the ureter is obstructed The non-toxicity of the sodium salts is therefore a great advantage and the potassium salts are now discarded Following the use of the sodium salts no renal damage can be detected by blood-urea creatine, or nitrogen estimations or by the indigo-carmine or phenolsulphonephthalein output tests If, however, operation is undertaken within the first two or three days after pyelography, some œdema of the pelvis is occasionally discernible

Cameron has shown that the molar 13 5 per cent solution of sodium iodide is as opaque to the rays as a three-molar 25 2 per cent solution of sodium bromide, that the osmotic pressure of the former is fairly close to that of a concentrated urine, whilst the osmotic pressure of a bromide solution is over three times as great This is important because, other things being constant, the injury produced by hypertonic solutions on living tissues increases with their hypertonicity Further, the bromide solution is more irritating to the kidney than is the iodide, and its viscosity is also slightly the greater of the two On the whole, sodium iodide 13 5 per cent solution, is the most serviceable medium we possess at the present time It is neutral in reaction, sterilizable by boiling and does not form precipitates with blood or urine. Symptoms of iodism are however, occasionally observed after its use in susceptible persons The solution can be made by dissolving 15 g. of the salt in a sufficient amount of water to make 100 g.

Though these solutions are easily sterilized none of them possesses any appreciable antiseptic value a quality which in view of the possibility of carrying infection to the kidney from the lower parts,

would be desirable Attempts to combine them with oxycyanide of mercury or with silver nitrate result in the production of highly irritating bodies as for instance silver iodide and in several instances (Praetorius Rafin) kidneys have had to be removed following such a procedure All mercuric compounds should in fact be excluded from the kidney I have more than once seen an intense albuminuria follow a mercurochrome bladder wash which had flowed up to the kidney

Lithium iodide was introduced as a urographic solution by L Joseph somewhat after the drugs described above appeared and is marketed under the trade name of 'Umbrenal' by Messrs Kahlbaum * It is put up in sealed ampoules which are filled under hydrogen gas to prevent splitting off of iodine Joseph claims that a 25 per cent solution gives a more intense shadow than previously used substances that it is unirritating, and is possessed of a certain antiseptic value

Since the introduction of uroselectan and abrodil for intravenous urography solutions of these drugs have been employed also for instrumental pyelography They appear to be the least irritating of all the solutions thus far discovered but their costliness is for the present prohibitive They give excellent shadows when the solutions used for intravenous injections are diluted and a preparation one fifth of this strength has been marketed in sterile ampoules The shadow casting properties of all these drugs depend largely on their iodine content (*see* page 475) Sodium iodide contains 84 7 per cent lithium iodide 94 8 per cent and the older uroselectan 42 per cent of iodine A 30 per cent solution of this uroselectan should therefore give a shadow approximately corresponding to a 13 per cent lithium iodide or a 15 per cent sodium bromide solution

Various gas media have been recommended but have never become popular Oxygen is the most suitable and was first used by Burkhard Braasch says that with them there is difficulty in keeping the pelvis filled with the gas and also that the shadow of the renal pelvis is easily confused with that of gas in the bowel The method therefore is of little practical value and in view of the possibility of embolism which can easily be produced in animal experiment and has in clinical work proved fatal gas media cannot be too strongly condemned (*see also* page 485)

Method of Injection —The capacity of the non pathological human pelvis varies considerably 4 and 14 c c representing outside limits Such pelves as those seen in *Figs* 249 263 and 262 *j* *l* *l* would offer very little space whilst examples like those in *Fig* 262 *f* and *h* would accommodate considerably more fluid It is advisable in the first

* Umbrenal is not at present obtainable

instance to assume that the pelvis is small and to inject no more than 5 c.c. of contrast solution. An exposure then made will indicate the available space. In the early days a number of accidents, including some fatalities, resulted from over-distension of the renal pelvis and the forcing of fluid up the uriniferous tubules of the kidney. In cases where nephrectomy was subsequently performed the colloidal silver then in vogue was found deep in the renal parenchyma, under the capsule, and even in the perirenal tissue. Its presence had caused extensive renal destruction, whilst in some instances infarcts, foci of suppuration, and in at least one case areas of gangrene were discovered. It was soon realized that these accidents were due to over-distension, the injection being forced, according to various observers, up tubules, through interstitial tissue, or along the lymph spaces. At necropsy in animals which died within five minutes of the injection of silver under high pressure the metal was found in distant organs as emboli. A factor contributing previously to renal injury was that in the presence of electrolytes such as are found in the urine many colloid solutions of silver are precipitated, which accounted for the discovery of deposits of the precipitated metal in the renal tissue after pyelography.

All observers are now agreed that pyelography with modern drugs is safe if the pressure of the injection is kept within strict limits (*see*, however, Chapter XXVI). So long as the pelvic pressure lies well below the level at which the kidney ceases to secrete urine no danger need be feared. In normal conditions the pressure in the pelvis is negligible, but when the ureter is obstructed it reaches a maximum of 40 to 60 mm. of mercury in about ten to fourteen hours, though much higher pressures have been registered. It should be safe, therefore, to keep the pressure of injection below 40 mm. of mercury. There are three methods of making the injection :—

1. *By Means of Gravity*.—A graduated tube or burette is filled with the solution and is raised a short distance above the level of the kidney pelvis. It may be arranged so that it is supported upon an adjustable stand capable of being raised or lowered as required. An elevation of a foot to eighteen inches should be sufficient to distend the average pelvis. If fluid in any quantity has been previously drained from the kidney, an equivalent amount, as shown on the graduated burette, may be forthwith replaced. If there is no evidence of dilatation, the injection should be stopped as soon as the capacity of the normal renal pelvis—say 5 c.c.—has been reached. The tube is now lowered to a few inches above the level of the pelvis, and a film is exposed. The continued flow of solution under low pressure thus obtained is serviceable in replacing any solution which escapes from the pelvis down the ureter. Whilst the film is being developed

as much as possible of the solution is withdrawn from the kidney by a hand syringe The plate is examined when ready, and it is decided whether the pelvis is adequately distended or requires further fluid to display its contour If a satisfactory negative and a filled pelvis have been obtained, the examination is concluded If the distension is inadequate more fluid is employed Over distension is guarded against by using a small catheter, by slow filling by keeping a look out for pain and also by exposing a film at successive stages to observe the requirements of the particular pelvis As much of this fluid is possible is removed by suction with a syringe before removing the ureteric catheter This is especially important when there is a large pelvis or stricture at any point in the ureter

2 *A Hand Syringe*.—This is employed by many surgeons, and, if used with care and a knowledge of possible danger is a simple and safe method The syringe shown in *Fig* 193 page 321 may be employed in conjunction with the conical nozzle (*Fig* 261) or the universal fitting (Fig 192 page 320) Syringes made with tapering nozzles are also obtainable An ordinary fairly large hypodermic needle attached to a Record syringe and passed down the catheter lumen serves quite well After the first barrelful has been slowly injected a film is exposed The remainder of the technique is similar to that described above

Fig [illegible]1.—Andrews pyelography nozzle with Record fitting

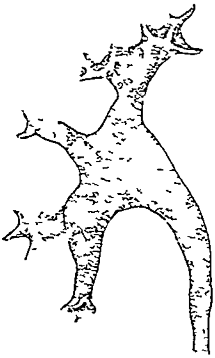
3 *Complicated Burettes*.—Burettes with manometers attached have been adopted by various writers (Papin Pannett and others) but are not necessary

Significance of Pain.—The pain produced by pyelography should be carefully noted It has diagnostic significance from two points of view —

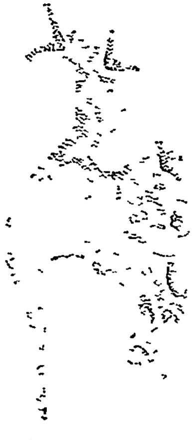
1 It varies in degree inversely with the size of the pelvis Large hydronephroses when sufficiently filled are almost or quite painless The closer the pelvis approximates to the normal the more is pain experienced

2 It is important to inquire from the patient regarding the type of his pain Does it correspond to that from which he is seeking relief? In many of these cases the pain which is the reason for the investigation is not yet at the time of the pyelography definitely imputable to the kidney If the discomfort of pyelography simulates that from which the patient has suffered it may be assumed that the kidney is the organ responsible

There appears to be a latent period in the development of renal pain For instance if the kidney has been filled to near capacity and a halt has then been called the patient does not complain for



a



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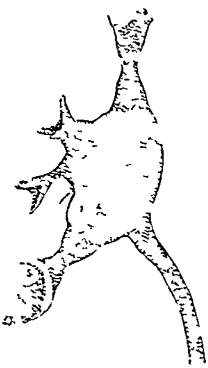

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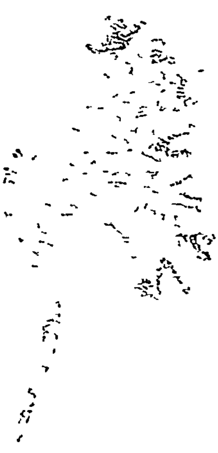


g

h

i

[illegible]

several seconds, after which the pain becomes progressively more intense for a further short period This delay in onset emphasizes the importance of injecting very slowly and intermittently, especially when the capacity of the pelvis is being approached There should never be any real tension in the pelvis Many films which one sees published in the literature appear to show overfilling The withdrawal of solution immediately after the radiograph has been taken has already been recommended

THE NORMAL RENAL PELVIS

There is much variety in the shapes assumed by the normal pelvis A knowledge of the normal is essential before abnormality can be detected and its significance correctly assessed

The renal pelvis presents a funnel- or trumpet-shaped outline continuous at its outer margin with the renal calices and at its inner and lower angle with the ureter Its junction with the ureter shows a slight constriction anatomically and in casts taken from the pelvis and upper ureter but this constriction is only occasionally discernible in a pyelogram The mesial border of the pelvis may continue the line of the ureter vertically into the upper calix with little deviation (*Fig* 262, *d*, *k*, *l* *p*, *t*), but more commonly this line is broken by a double curve first outwards and then upwards, so that the calix, though more or less parallel to the ureteric line, is more externally placed (*Fig* 262, *a*, *c* *g*, *h*, *o*, *s*, etc) The lower border of the pelvis diverges rapidly from the mesial, sweeping over with a regular and shapely curve into the lowest calix The outer margin receives the middle calices

Variations in the Normal Pelvic Contour.—These depend chiefly upon the respective extent to which the calices and the pelvis proper are developed The range of appearances within the normal is a very wide one and for this reason tracings of twenty normal pelves, selected because of their diversity, are illustrated Three principal types may be described —

1 *Type A*—In the first and most usual type (*Fig* 262, *a*, *b*, *c*, *i* etc , also *Fig* 276, left pelvis, page 456) the triangular outline of the pelvis is well marked, receiving above the upper calix, below, the lower, and at a point near its centre, one or more shorter calices

It is convenient at this point to describe the appearance of the calices These are divided into major and minor The *major* or primary calices are usually three in number, an upper, which is roughly perpendicular in direction, and is frequently long—over one inch, a middle one—sometimes double—which passes outwards and a lower calix which curves outwards and downwards When long these

calices are seen to be slightly constricted at their middle, but when short they are generally stout and have parallel margins

Two, three, or more *minor* or secondary calices cap the extremity of each primary calyx, and in the pyelogram they appear as a fimbriated termination to the latter. Their extremities are cup shaped and embrace the apices of the papillæ. When favourably placed their concave form may be suggested on the pyelogram but more commonly they are seen in profile and appear pyramoid. When seen end on they appear circular. In the middle area of the kidney the minor calices face anteriorly, posteriorly or externally according to the portions of the organ which they drain. The shadows of the anterior and posterior groups often overlap on the plate. At the two poles the calices face as above but additional cups are present looking inwards and upwards in the case of the upper pole, downwards (rarely inwards) in the case of the lower, to drain the extremities of the gland. The minor calices are therefore more closely grouped at the two poles

The delicate contour displayed by these cups is one of the first things to undergo change as the result of mechanical distension. Owing to their small size their shadow also suffers more readily from movements during the exposure of the film than does that of the coarser elements

2 *Type B*.—In the second type (*Figs* 262 *j*, *k*, *l*, *m* and 263) the familiar funnel shaped pelvis has been encroached upon by an unwonted development of the major calices and in well marked instances the pelvis proper ceases to exist (left pelvis in *Fig* 249, page 407). There is then an upper and a lower calyx and the condition differs only in degree from that known as bifidity of the renal pelvis. The pelvis is Y or T shaped, the middle calyx opening into the upper or lower branch or occasionally at the angle between the two (*Fig* 262 *k*, *l*). Papin prefers to describe this as the typical form and regards the other varieties as modifications resulting from effacement of the angle of bifurcation

3 *Type C*.—In the third type (*Fig* 262 *q*, *t*) the pelvis proper is more developed and absorbs the major calices so that the minor calices open directly into the pelvis itself

These three types are selected in order to facilitate description but that intermediate varieties are constantly observed is obvious from a study of *Fig* 262

In interpreting a pyelogram it should be borne in mind that the shadow is only a silhouette of the renal pelvis and it must be judged accordingly. Parts of the tube may be foreshortened and unless care is exercised this may lead to erroneous deductions. Thus the ureter often approaches the pelvis on a plane which is not quite perpendicular so that it appears to be implanted above the lowest

point This appearance may be artificially produced when the catheter has been pushed so far that its tip is arrested in a calix and the ureter becomes bowed in an anteroposterior direction Implantation of the ureter above the lowest point of the pelvis is a sign of commencing hydronephrosis. and its artifical production must not be confounded with that pathological condition The upper and lower major calices as a rule present their full length to the rays but frequently the middle one is foreshortened (*Fig.* 262, *f, h m*). The middle calix is normally shorter than the other two, and by such foreshortening this feature is accentuated Occasionally the extremities of the calices overlap, and in so doing present the appearance of inosculating This, however is artificial as may be demonstrated by taking a fresh radiograph from a different angle

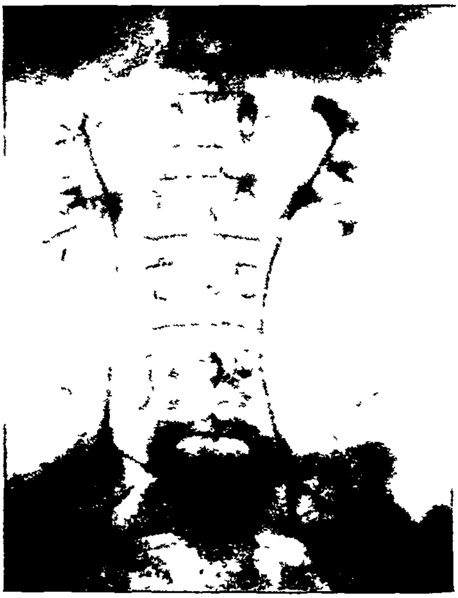


Fig 263 —Bilateral normal pelves Minor calices beautifully cupped The left pelvis is a characteristic *Type B* Note that the middle section of the kidney drains equally into the upper and lower major calices The right pelvis is a form intermediate between *Types A* and *B* The catheter enters the upper calix on each side, and on the left the ureter has been deflected so that it overlies the spine

Position of the Normal Pelvis.—When the X-ray tube is centred just above the umbilical line the ureteropelvic junction is situated on a level with the transverse process of the 2nd lumbar vertebra, being slightly higher on the left than on the right side This relationship is very constant with the normally situated and non-mobile kidney, and if altered displacement or mobility can be diagnosed It offers a better criterion of the position of the kidney than does the situation of the calices whose development is very variable. These latter may reach in the upward direction as high as the 11th rib The extremity of the lowest calix rarely descends below the transverse process of the 3rd lumbar vertebra in health

CONGENITAL ABNORMALITIES OF THE KIDNEY

(*See* Chapter XXIII page 373)

MOVABLE KIDNEY

Movable kidney can as a rule be diagnosed by palpation and pyelography is only indicated for the investigation of concomitant

disease or to establish the presence of pelvic dilatation Films should be exposed both in the upright and in the recumbent position in order to show the excursion of the kidney the tube and film as far as possible retaining the same relationship to the kidney A mobile organ may retain its upright position when dropped but more commonly it swings on its vascular pedicle so that when it is under the costal margin it assumes its usual upright attitude but as it descends its lower pole approaches the midline and its hilum which normally looks directly inwards now faces upwards the ureter approaching it from above and the upper and lower calices becoming horizontal Occasionally the kidney may reach or even cross the midline In pronounced prolapse the shadow lies opposite the 4th or 5th lumbar vertebra but it may actually overlap the iliac crest Sometimes even in this position the pyelogram shows that the kidney is upright

The ureter becomes redundant in length owing to the diminished distance between the kidney and bladder It therefore presents a certain degree of tortuosity It may be normal in calibre but is frequently slightly dilated and atonic Owing to its flaccidity and tortuosity it often happens that the point of the catheter picks up a fold of mucosa and is held up An artificial kink is thereby produced on the pyelogram This is particularly likely to occur at the point where the ureter is approaching the kidney for it has here to negotiate a wide curve to reach the upward facing pelvis A stiff catheter will markedly displace the ureter bowing it inwards so that it may even overlap the bodies of the vertebrae These kinks and artificial curves disappear if the catheter is withdrawn after injection of the medium Some kinks of the ureter are seen only when the patient is upright

The pelvis itself may be normal in form but it usually shows some slight degree of dilatation This is sometimes atonic comparable with that already shown to occur in the ureter At others it is due to back pressure varying degrees of hydronephrosis being observed (*see Fig* 267 page 452) Kinks near the ureteropelvic junction may then be ascribed to adhesion between the ureter and the dilated hydronephrotic sac Definite distension of the pelvis is an indication for operative interference it also supplies an objective explanation for some of the symptoms which are usually regarded as purely subjective

HYDRONEPHROSIS

Small Hydronephroses—The detection of early pelvic distension was the first field to which pyelography was applied and it is still a very important province Pyelography is the only available method of diagnosing the minor degrees of pyelectasis and as a great

deal of renal pain is attributable to this cause, its importance is obvious. It must be remembered that the operative demonstration of early renal distension is far from easy, and the importance of an accurate diagnosis prior to operation is thus greatly increased. Pyelography therefore fills in a serious gap in our diagnostic armamentarium.

In pre-pyelographic days a hydronephrosis was diagnosed by a tumour palpable in the loin causing, in all probability, recurrent attacks of colic. Modern methods in the diagnosis of renal pain soon teach that such gross instances of pelvic dilatation are rare in comparison with the minor degrees to the detection of which pyelography is so usefully applied. Renal pain is probably more severe at the onset, when distension is actually increasing and renal secretion is copious, than when the hydronephrosis is large and the parenchyma reduced in quantity, so that the patient is more likely to request treatment at this period than later. In a great many of these early cases the diagnosis is possible only by pyelography, being missed both clinically and even at operation.

In the absence of pyelography the pain of an incipient hydronephrosis may be erroneously attributed to some other organ (appendix, gall-bladder, etc.). Complete absence of other symptoms or signs pointing to the urinary tract is characteristic of this complaint, and tends to mislead. On the other hand, there are instances in which the urinary tract is wrongly suspected of being the seat of pain. Even with a healthy urine, a negative radiograph and satisfactory renal elimination, doubt may still linger and a normal pelvic outline will be valuable evidence in excluding renal disease.

Large Hydronephroses.—Large hydronephroses are generally recognizable by the history and signs, but many come to the urologist during a quiescent period when the sac is flaccid and he himself has no opportunity of gauging its size. For this purpose and also in the search for an underlying cause a pyelogram will usually be made. A certain amount of discretion is called for because the large sac will not be easily emptied through the catheter and the natural drainage of the kidney is defective. Some pyelographic fluid is, therefore, likely to be retained in the pelvis or to be absorbed by the kidney (*see* Chapter XXVI). Though as a rule no harm results, the effort to extract the solution should be a determined one, and only enough fluid should be used in the first place to allow an accurate diagnosis.

A large hydronephrosis should not be completely filled. *Fig* 277 (page 456) is unnecessarily distended and *Figs* 272, 273, and 317 (page 481) represent better practice though care must be exercised to avoid failing to appreciate the real size of a hydronephrosis of which

only one loculus has received fluid (*see* page 453 and *Figs* 275 A B) These remarks are not applicable to small and middle sized sacs which always require to be sufficiently distended if thin features are to be properly displayed

Excretion urography has much to recommend it in this class of case and in spite of the great loss of renal function it generally gives at least a sufficient shadow, the density being increased by the great depth of the fluid and by the retention of the dye In the event of there being no excretion the absence of a shadow carries its own significance

It will generally be possible to tell by a study of the history and symptoms whether a renal enlargement is a hydronephrosis or a neoplasm but in cases of doubt a pyelogram will show whether the pelvis is distended to form a sac or has undergone such changes as are seen in renal neoplasm or congenital cystic disease of the kidney (*see* page 462) If the ureteric catheter can reach the renal pelvis the evacuation of the retained urine and the disappearance of the swelling will itself be evidence of the hydronephrotic nature of the enlargement but where the catheter sticks and the sac cannot be drained pyelography will be required

When a hydronephrosis conforms to that type which shows a congenital narrowing of the ureteropelvic junction or to strapping by an abnormal tail vessel (*see Plate XV*) pyelography is more instructive when applied to the opposite organ than to the obviously diseased one in view of the tendency of the trouble to be bilateral The opposite pelvis may exhibit some degree of deformity which though slight and inappreciable by other examinations may affect the prognosis and treatment I have on two occasions seen nephrectomy of the palpable kidney promote a rapid distension of the remaining organ This is due to the increased work thrown on it Thomson Walker discussing the relationship of diuresis to hydronephrosis says There are many cases of congenital valves and narrowings of the ureter in which the lumen is sufficient for the escape of the urine under ordinary conditions but is too narrow to drain a sudden diuresis From the comparative obstruction thus established hydronephrosis begins to develop and the pressure it exerts upon the ureter increases the obstruction ' Apparently the additional work to which these organs are subjected by the removal of their fellows although slight may be enough to precipitate the development of a hydronephrosis Pyelography may show whether the second kidney has a tendency to develop a hydronephrosis and will thus be of assistance as an operative indication and also from the point of view of prognosis Excretion urography is valuable in this respect (*see Fig* 336 page 520)

In the case of intermittent hydronephrosis Papin has shown that during the attack of retention it is frequently impossible to introduce fluid into the kidney but when the attack is over the obstruction disappears and a pyelogram may be obtained.

Evidences of Renal Distension on the Pyelogram.—Large and medium sized hydronephroses are easily diagnosed pyelographically, but it requires much care and acumen to recognize the earliest phases and to decide whether the condition is a variety of the normal or is pathological. Yet these minor distensions give pronounced symptoms and are the ones where assistance is most required, whilst pyelography is the only available method of diagnosis.

Small Hydronephroses.—Distension will naturally first affect the delicate minor calices and later the more fibrous pelvis. Pressure atrophy also occurs early in the papillæ so that they are flattened. The earliest pyelographic change therefore is seen in the cup-shaped *minor calices*, which become decreasingly concave and are eventually flattened or even convex (*Fig.* 264). The major calix with its distended

Fig. 264.—The progress of calicine distension.

minor calices thus assumes a club-shaped appearance. This is perhaps the most important of all early changes from the diagnostic point of view.

The next structure to be involved is the *major calix*, its boundaries being pressed back so that it becomes broader and loses the slight waist which is generally to be observed in the normal state. Increase in the length of the calix may or may not be noted, for often atrophy affects equally the depths of the sinus and its portals—intercaliceal papillæ. Later the calices are definitely shortened. Dilatation is almost invariably seen at the poles before becoming evident in the middle calix (*Figs.* 267, 269 and 270).

It is not possible to say whether the *pelvis* itself is dilated until the process is well advanced, for normal pelves vary considerably in size, and before saying that any given example is dilated it would be necessary to know the natural dimensions of that particular pelvis. Up to 15 c.c. may be looked on as not necessarily outside the normal capacity. If an outsize pelvis is the natural state of a particular individual both kidneys will probably show the peculiarity. A pyelogram of the other kidney will indicate the patient's normal.

A significant change which may escape observation unless specially looked for is an alteration in the symmetry of the curve which

the upper ureter makes with the lower margin of the pelvis. "An early change which occurs when dilatation is developing is angulation of the lower ureterocalicine curve This becomes more and more

Fig 265—Tracings from various cases of minor pyelectasis

acute as the lower calix approaches the upper ureter" (Thomson Walker) Later the position of implantation of the ureter alters and it comes to appear to be inserted at a point on the median border of the pelvis though as previously stated, this appearance may occur in the normal as an artefact due to the ureter approaching its insertion

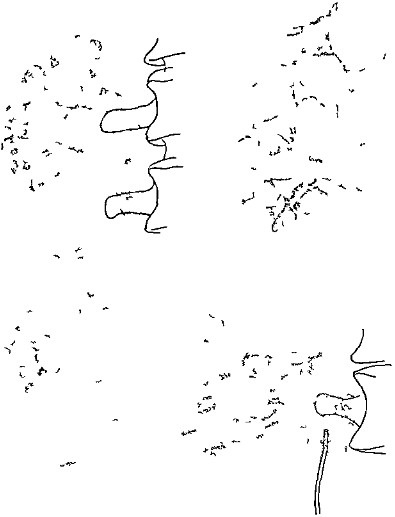


Fig 66—Pyelectasis of moderate severity

in the anteroposterior plane Sometimes an early hydronephrosis will remain unrecognized when insufficiently distended because it appears of the usual size

Medium sized Hydronephroses—As distension progresses all the features enumerated above become exaggerated the pelvis is larger, the calices are broader and shorter and the ureteric insertion is more displaced

Large Hydronephroses—As before stated, pyelography is not absolutely indispensable for those cases which can be diagnosed by symptomatology and abdominal palpation, but it is usually undertaken Little or no pain is caused by the distension of a large sac. When a considerable amount of urine is withdrawn by the catheter, this may be straightway replaced by an equivalent amount of solution, but where there is uncertainty regarding the size of the pelvis, films should be exposed at intervals in order to check progress The sac is usually single, and the pyelographic shadow varies in contour according as the pelvis (pelvic hydronephrosis) or kidney (renal hydronephrosis) has borne the brunt of the dilatation Frequently it has been evenly distributed between the two (mixed hydronephrosis) (*see Figs* 272, 276, 277)

Fig 267 —Moderate distension due to movable kidney Note low position Upper and lower poles much dilated and the major calices very broad The middle calix is virtually normal, the brunt of the distension falling as usual on the poles Tip of catheter is caught at ureteropelvic junction causing distortion

Fig 268 —Retrograde pyelogram The pelvis is incompletely filled Dilatation is of moderate severity The catheter tip is seen to reach only to the transverse process of the second lumbar vertebra The rounded object with clear centre on the right side is the shadow of a gall stone

In the *pelvic* type the enlargement occurs chiefly outside the renal sinus (extrarenal type) The pelvis is greatly enlarged and is often more or less rounded (*Fig* 271), though it may retain its triangular contour A considerable quantity of renal tissue remains, though it is generally more or less excavated by secondary chambers opening into the main cavity

In the *renal* type the pressure is chiefly felt inside the limits of the sinus (intrarenal type) (*Fig* 273). The pelvis may be little or not at all dilated whilst the parenchyma is greatly reduced in thickness. It may take the form of a single smooth walled cavity but more commonly the pyelogram shows a central cavity into which open

Fig [illegible]9.—Inflammatory dilatation of the right pelvis. Left side normal. Note the curling up of the catheters. The widening and parallel sides of the major calices are very obvious and also the almost complete absence of minor calices. The broad and uniformly full ureter suggests an atonic condition.

Fig [illegible]0.—Distension of moderate severity. Pelvis not quite full and fluid has gravitated to the lowest lying parts which show a more pronounced shadow (upper and middle calices). The middle calix is less dilated than the polar calices. Cf. *Fig* [illegible] A.

numerous secondary loculi (*Figs* 272, 273) exhibiting an undulating or more deeply scalloped external border in correspondence with the lobulation which can be observed on the surface of the organ. The septa between the cavities correspond to fibrosed columns of Bertini. Frequently the various parts of the cavity receive the opaque solution unevenly owing to its not mixing intimately with the urinary residuum (*Figs* 272, 273, 317 left side, page 481). Sometimes when filling a very large and much loculated hydronephrosis it happens that the fluid goes on accumulating in the loculus immediately below the catheter tip till the latter is full and a radiograph taken at this time would give a picture limited to this one loculus and a completely erroneous impression of the size of the organ. Further filling would cause an overflow into one or more neighbouring sacs. The cavity first filled is sometimes a centrally placed one but quite often it is

Fig 271 —Hydronephrosis due to aberrant vessels Pelvic type Calices clubbed but still well formed Pelvis lies opposite third lumbar vertebra

Fig 272 —Hydronephrosis of mixed type and congenital origin—pelvis and calices both much dilated Pelvis could not be emptied prior to injection of solution, which has incompletely mixed with the contained urine, and has outlined the rounded upper calices distinctly, but the pelvis and lower calices less well

Fig 273 —Hydronephrosis of large size incompletely filled

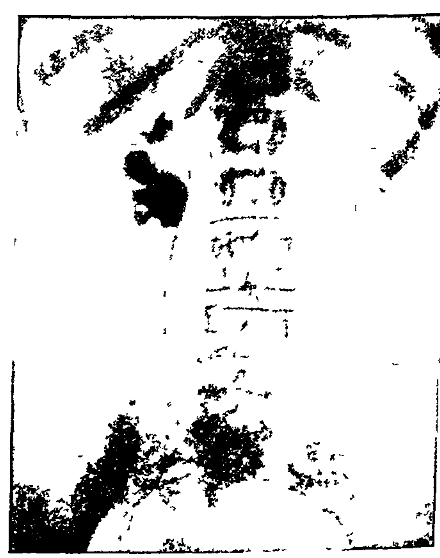
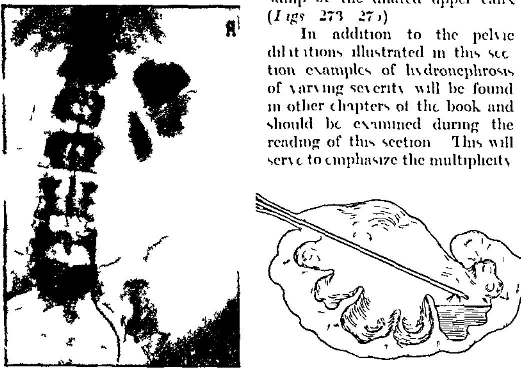


Fig 274 —Minor pyelectasis in the lower element of a double kidney The distension falls principally on the topmost major calix of this section of the kidney, the upper pelvis being normal

the ballooned cephalic pole of the kidney which in the recumbent position is low lying and into which the catheter may have run (Fig 275 B). At other times the fluid simply gravitates into the dependent sump of the dilated upper calix (Figs 273, 275).

In addition to the pelvic dilatations illustrated in this section examples of hydronephrosis of varying severity will be found in other chapters of the book and should be examined during the reading of this section. This will serve to emphasize the multiplicity of the causes and the prevalence of dilatation. The following list will expedite the search —



A B

Fig 275.—A Instrumental pyelogram illustrating the way contrast fluid may select one portion of a large hydronephrosis in this case the upper calix for filling in the first instance. The remainder of the sac which is faintly visible extends to a point ½ in below the iliac crest and would easily have been overlooked. B Diagram (lateral view) illustrating the way fluid fills one part of a hydronephrosis and subsequently overflows into the next loculus. It is even more common for the fluid to reach the dependent cephalic end by trickling down to it as is happening in Figs 270, 273 and 275 A

Chapter	VII	Figs 71, 72, 77–79
	XI	Fig 108
	XIX	Fig 183
	XXI	Figs 201, 207, 208, 210–212
	XXIII	Figs 223, 225, 227, 229, 231, 232, 234, 237, 240, 248, 252, 257
	XXV	Figs 278, 281, 282, 284–290, 292, 293, 295, 299, 300, 302, 304, 306, 310–313, 315–318
	XXVII	Figs 335–337

HYDRO URETER

The correct reading of a ureterogram is even more difficult than that of a pyelogram and it is certain that a great many mistakes

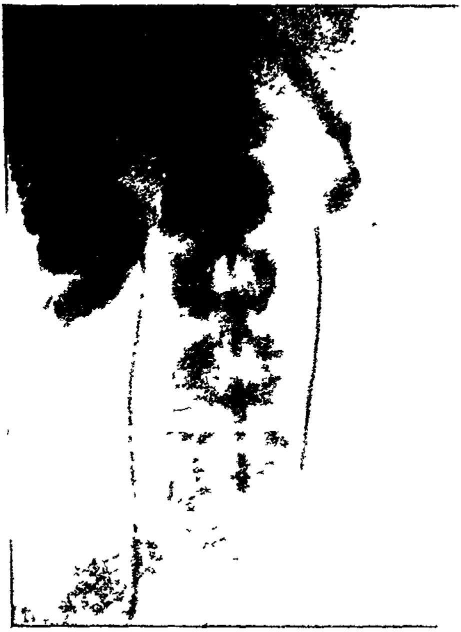


Fig 276.—Cystoscopic pyelogram bilateral. Shapely normal pelvis on left (*Type A*). Severe grade of distension on right, the large pelvis and grossly clubbed calices being evident.

Fig 277.—Huge hydronephrosis overlaps 11th rib above and iliac crest below. Note the inward position of the uretero-pelvic junction. It is generally unwise to fill as full as has been done here.

are made in interpretation even by experienced workers. It is therefore desirable to warn beginners against a hasty or ill-considered diagnosis based on ureterographic evidence which may be misleading. The diagnosis of ureteral stricture or kink is frequently made on insufficient grounds: such indications should be definite, and similar

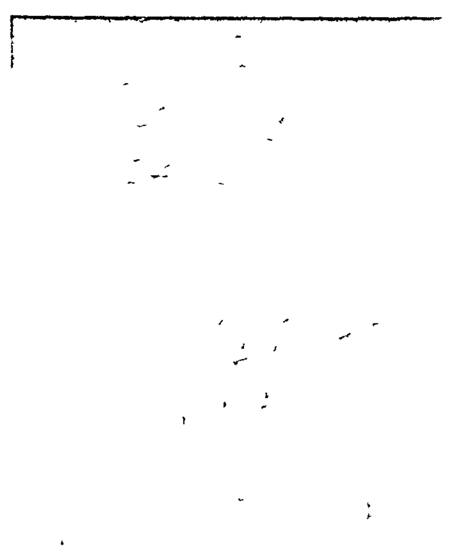


Fig 278.—Stricture of the ureter from peri-ureteric inflammatory tissue probably appendicular in origin. Severe bulbous dilatation of the ureter immediately above the point of pressure tailing off above with only minor effects on the pelvis but the minor calices have lost their cups.

outlines should be seen in the same section of the ureter on more than one film before it is accepted as authentic. When the pyelographic evidence is unconvincing, and especially if the complaint is of recent

development, all the possible alternatives should be fully explored before the diagnosis is made, and the ureterogram should be considered in conjunction with all the clinical data. There are three fallacies in particular which lead to erroneous interpretations:—

1. The normal variation in the bore of the ureter is well recognized, it having narrowings at the pelvic outlet, brim of the true bony pelvis, and at its vesical extremity (*Fig.* 279). Between these points of diminished calibre are well-marked fusiform dilatations. Histologically the narrowed sections can be shown to contain an excess of circular muscle, and it is thought possible that the contents of the tube may be temporarily locked up in the intervening compartments, giving an appearance suggestive of dilatation on the pyelogram. The position of these congenital narrowings determines the position at which stones traversing the ureter get caught, and at which these stones leave behind them ureteral injury or ulceration which in its turn may cause stenosis during healing. It is therefore evident that the sites of congenital and physiological narrowing coincide with those of pathological contraction, so that the differential diagnosis calls for care.

2. The peristaltic wave of the ureter is often evident in the pyelo-ureterogram, especially when the tip of the catheter falls short of the renal pelvis. Above and below these spindle-shaped waves are lengths of the ureter which are physiologically empty. The novice may misinterpret them as pathological. A second film will probably show the spindle in a different position.

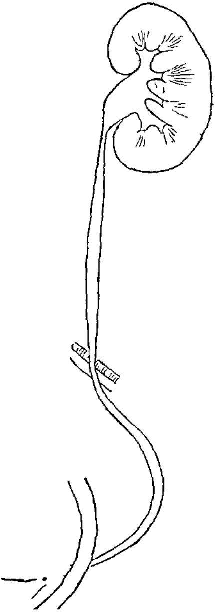


Fig. 279.—Diagrammatic representation of the variations in width of the normal ureter.

3. A ureterogram may be made by filling the renal pelvis and allowing its contents to flow down the ureter, or by distending the ureter from below whilst the catheter tip is in its lowest segment (*see also* Chapter XXVIII). In the first case

the catheter must be withdrawn before exposing the film, as otherwise the ureteric shape is liable to be distorted, owing either to the rigid instrument displacing it laterally or anteroposteriorly, or to its picking up a fold of mucosa and causing a kink (*see Fig* 276, page 452) The ureter, as a result of either of these accidents, may be foreshortened and appear to be strictured

Apart from disease, malformation, or artificial distortion, the ureter may run a slightly devious course to which no pathological

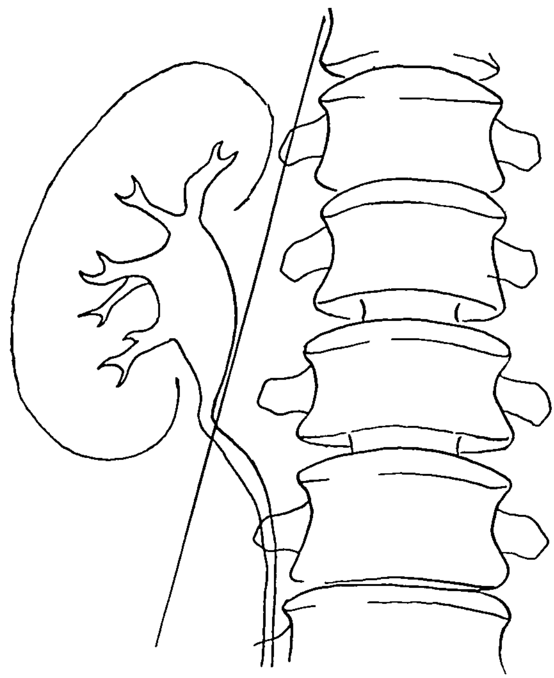


Fig 280 —The relationship of the kidney to the psoas muscle is evident The pelvis lies external to the muscle in the hollow under its shelter The ureter generally runs a straight course downwards but sometimes climbs up steeply on to the belly of the psoas and then appears on a urogram to be twisted or even kinked

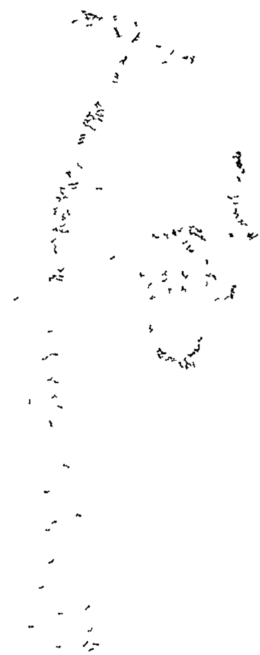


Fig 281 —Dilatation affecting one portion only of a double kidney The pelvis and ureter are more affected than the calices

significance must be attached Foreshortening of the ureter as it climbs on to the psoas muscle (*Figs* 280, and 71, page 129), produces an appearance which is easily recognized once it is known, the more so as the shadow of this muscle is readily identified on the film

The most usual site for obstruction is the ureteropelvic junction, but it may occur at any point along the ureter, when the section above the stricture will be dilated (hydro-ureter) (*Fig* 278) When the obstruction affects one branch of a bifid pelvis or a bifid ureter (*Figs* 274, page 151 and 281) its consequences will be limited to that branch and to the corresponding portion of the kidney (partial hydronephrosis)

A school of thought led by Hunner attributes great importance to ureteral strictures and considers that many vague abdominal symptoms which are usually variously attributed to the appendix, ovary or to pelvic adhesions arise from these strictures. Much scepticism, however, prevails elsewhere in the profession regarding this condition. It is said to be diagnosable by the passing of 'bulbed' bougies and noting the resistance as they pass the point of stricture and the 'hang' as they are withdrawn. If an ordinary catheter is used the diagnosis is missed because the sensation is not elicited. Pain is experienced by the patient as the bougie passes over the affected point. The strictures occur at those positions where nodes are found in the normal ureter—the ureteropelvic junction, the pelvic brim, the broad ligament and the intramural section. There are generally no vesical symptoms and the urine is usually clear, the diagnosis being based entirely on the cystoscopic findings and on the fact that dilatation cures the symptoms. Pathological, including post mortem, evidence of a genuine stricture has not as yet been forthcoming. Foci of infection in the teeth, tonsil and other distant structures have been blamed (which is not consistent with the behaviour of other ducts in the body) and also local infections in the bladder, prostate, cervix, etc.

Fig. 282. Megalo-ureter. Extreme dilatation of congenital origin.

CONGENITAL DILATATION OF THE URETER (MEGALO-URETER)

Congenital dilatation of the ureter is not infrequently seen, and takes two forms:—

1. A dilatation comparable with congenital idiopathic dilatation of the colon. It is usually of severe development, may be unilateral or bilateral and does not extend below the uretero-vesical orifice (Fig. 282). In the example seen in Fig. 240 (page 197) the large size of the ureter and pelvis is obvious but it is most easily seen in the upper reaches. This was a solitary kidney. Some authorities regard this condition as a

neuromuscular dysfunction. Others look on it as a failure of the primitive ureter (which is of large size in proportion to the body bulk) to assume its subsequent customary proportions.

2. The ureter may be affected by back-pressure from some congenital urethral malformation—valves, etc.

SIMPLE INFLAMMATORY CHANGES IN THE KIDNEY

Pyelitis and pyelonephritis lead as a rule to some minor degree of pelvic dilatation, the brunt of which is borne in different cases by the calices, pelvis, or ureter. Simple pyelonephritis sometimes causes erosion of the renal papillæ, the damaged areas then showing up on the pyelogram as rounded excavations of the parenchyma. The ureter may be uniformly or irregularly dilated, and in some cases exhibits a sinuous outline.

A pyonephrosis may arise from infection of a hydronephrosis, when its outline will be similar in shape to that of its forerunner. It may assume a pelvic, renal, or mixed distribution, and be small or very large. Often it is impossible to drain its contents through a ureteric catheter owing to their thick consistency, and the pyelographic solution must be added to the already contained fluid. The medium tends to fill the cavities irregularly, and where these are lined with adherent debris the outline of the cavity is irregular and hazy.

CARBUNCLE OF THE KIDNEY

This condition, which is far from common, has attracted a certain amount of attention recently. It is a very definite entity, not to be confused with certain other suppurative lesions of the kidney. *Fig.* 283 A is a drawing of a characteristic renal carbuncle and the striking resemblance to the common carbuncle of the neck is self-evident. It shows multiple purulent foci and, as is almost invariably the case, it occupies the cortical part of the kidney. As the carbuncle increases in size it approaches the capsule, through which it not infrequently oozes, infecting the perinephric tissues. It is rare for it to rupture into, or even to approach, the pelvis, and in many patients the urine contains neither pus nor organisms. The usual organism is a staphylococcus and in a large percentage a definite history of a primary focus, generally a furuncle of the skin, from which metastatic infection has taken place, is available. Brady, in 88 collected cases, got such a history in 73. The subjects are generally young adults (3rd or 4th decade) and men are affected 2½ times more often than women. The patients are usually extremely ill, but localizing symptoms are often missing. Curiously, the right kidney is more frequently the site of the carbuncle than the left (1 : 3), but a point to remember is that in approximately one-fifth of the patients the condition is bilateral, so that close attention should be paid to the second kidney.

The pyelographic appearances are precisely such as might be expected from the presence of an inflammatory mass in the renal cortex but they naturally vary with its size and location The renal outline may be somewhat enlarged but is never grossly so Calices subtending the affected part of the kidney are compressed and obliterated those draining the adjacent parenchyma may be elongated Most of these features

B

A

Fig 283 —A Carbuncle of the kidney The centrally placed carbuncle bulges into the pelvis and the filling defect of the pelvis and middle calyx seen in B faithfully portrays the anatomical deformity

are shown in *Fig* 283 B Spence and Johnston collected reports of 30 cases and analysed the pyelographic findings as follows —

Filling defect or deformity of the renal pelvis	16
Enlarged kidney outline	15
Absent or indistinct psoas shadow	10
Obliteration of one or more calices	7
Significant dilatation of the renal pelvis	3
Normal	4

The pyelogram therefore shows some alteration in a high proportion of cases and should be suggestive Nevertheless a correct preoperative diagnosis has been the exception rather than the rule

Operative treatment has been universal in the past, but penicillin will probably play a role in the future. Opinion has hitherto been divided between nephrectomy and conservative measures Nephrectomy carries a rather lower operative mortality and a quicker convalescence, tedious suppuration often resulting from conservative drainage But these advantages are offset by the retention of a valuable functioning kidney when conservative treatment is successful If the kidney is extensively destroyed (one third or more) nephrectomy would probably be indicated, if a perinephric abscess has formed, with its attendant adhesions excluding extraperitoneal spaces, drainage of the abscess together with incision or excision of the carbuncle and penicillin therapy would be the procedure of choice

RENAL TUBERCULOSIS

(*See* CHAPTER VII page 113).

POLYCYSTIC KIDNEY

In polycystic disease the renal pelvis is invaded by multiple cysts and its cavity is deficient where they trespass upon it The cysts, being convex towards the pelvic cavity, are outlined by concave shadows on the pyelogram (*Figs* 284–287) When well developed the cysts may almost completely obliterate the pelvis, and the pyelographic contour is much compressed and consists of narrow, erratic streaks with concave margins The vertical measurements of the pelvis are invariably greatly increased, and this is true also of the anteroposterior ones, but this is not recognizable unless lateral views are obtained Long arms of the pelvis reach out to drain areas of parenchyma which have been ousted from their original situation by the interposition of the cysts, and they appear as irregular straggling shadows the extremities of which stretch well beyond the usual limits of the renal pelvis (*Figs* 284–287) Some of these elongated and widened calices show a relatively clear central area shading off to the darker periphery, caused by a rounded cyst bulging into the calix A considerable development of cysts in the upper pole of the kidney may displace the pelvis downwards (*Figs* 285, 286), whilst a similar enlargement at its lower end may modify the course of the ureter (*Figs* 285 287)

The condition is invariably bilateral, as can be demonstrated by taking a pyelogram of the second organ Two instrumental pyelograms should not however, be made simultaneously Excretion urography is for the most part, unsatisfactory owing to inferior excretion of the dye The radiographic diagnosis between polycystic kidney and renal growth should not be difficult, though the deformities produced are in some respects similar (*see* page 466)

Fig 284 —Advanced polycystic disease of the kidney The long spidery pelvis is characteristic Large cysts occupy the spaces between the calices The pelvis reaches a low point

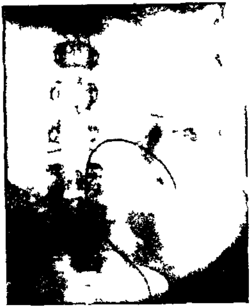


Fig 285 —Polycystic kidney The kidney is pushed down by the development of large cysts in the upper pole No operative confirmation Ureter displaced over spine

Fig 286 —Polycystic kidney Note large straggling pelvis long arms concave shadows downward displacement of kidney and redundant ureter

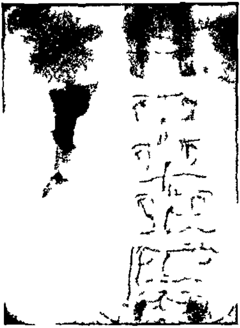


Fig 287 —Polycystic kidney Note that the ureter is displaced so as to overlie the spine evidently as a result of cystic development in lower pole

and often extreme Sometimes the pelvis and calices are represented on the pyelogram by a few irregular and often widely separated blotches "In pushing into the cavity of the pelvis, the tumour very often leaves a thin, compressed cup-like extension of the pelvis about the periphery of the tumour mass" (Young and Waters) (*Figs* 288, 290) Ascending pyelography is almost invariably preferable to descending owing to the more certain delineation The latter is frequently unsatisfactory, especially in advanced disease The silhouette of that part of the tumour which occupies the parenchyma can often be made out on a plain film and even more so on a pyelogram (*Fig* 288)

Fig 292—Stone in the renal pelvis (*a*) The pelvis was filled with pultaceous material, probably changed blood, and this accounts for the irregularity of the pelvic shadow, which has a vacuolated appearance It illustrates the effect on pyelography of foreign material in the pelvis (cf *Fig* 293)

When a tumour bleeds into the pelvis the resulting clot may be responsible for a filling defect The shadow lacks the definition produced by many tumour edges and tends to be ill-defined, diffuse and of uneven density Any other renal lesion capable of causing hæmorrhage may, of course, equally with a tumour be responsible for a filling defect. *Figs* 292 and 293 show two examples both of which happen to be due to calculi

Diagnosis—Radiologically parenchymal tumours affect the pelvis in some respects like polycystic disease They bulge into the cavity with a convex outline which may be embraced by long spidery arms (*Fig* 290), and they cause similar displacements of the kidney (*see below*) But they are generally distinguishable because (1) the encroachment is single rather than multiple, so that one section of the pelvis alone, or principally, is affected, whereas in congenital cystic disease all parts are involved and the spidery arms are more widespread and numerous and often more clear cut, (2) the shape of the distortion is often quite evidently not referable to a rounded cyst, (3) polycystic disease is bilateral, a renal carcinoma unilateral

Though a renal carcinoma bulges into the pelvis and eventually more or less fills it, it practically never corks the outlet and as a

result a hydronephrosis is very rarely associated This is a point helping to differentiate between a parenchymal carcinoma and a growth originating in the pelvis which latter very commonly produces obstruction and pyelectasis (see page 469)

Fig 393 — Ascending pyelogram Notable filling defect due to thick grumous material (as proved at operation) probably changed blood clot Stricture at ureteropelvic junction catheter coiled up just below this Moderate pyelectasis Stone shadow near tip of transverse process of second lumbar vertebra

Effect of Tumours on the Position of the Kidney —

Intrarenal Tumours —Growths of large size arising in the kidney itself may cause displacement of the remainder of the gland This is especially true when they involve the upper pole The pelvis, in addition to being distorted is then found to occupy a position lower than the normal and sometimes also to be rotated

Growths in the lower pole cannot displace the kidney upwards in the same manner as a growth of the upper pole pushes the gland downwards partly because of the immovable structures above the

kidney and partly because, in contrast with the growths of the upper pole, they are free to enlarge away from the renal pelvis A large lower pole tumour throws the ureter inwards so that it runs a curved course and its shadow not infrequently overlies that of the vertebral column Many descriptions of these growths overstate the preponderance of tumours arising in the upper pole In the writer's opinion it is doubtful if they are any more common there than in the rest of the gland.

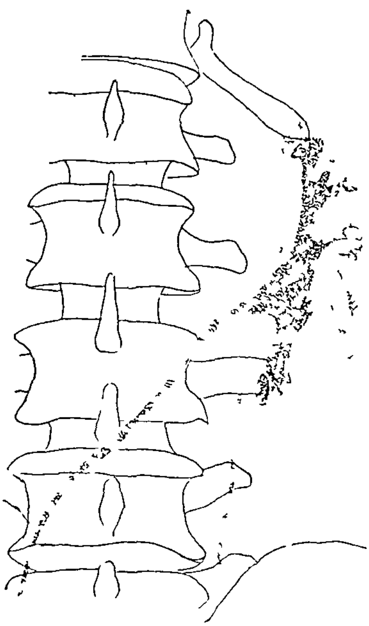


Fig 294 —Extreme displacement of the right kidney (heavy dotting) by an extrarenal growth The kidney lies on the left side of the spine and overlies the left kidney (light dotting) (cf *Fig* 230, page 386) (*Mr Garnett Wright's case*)

Extrarenal Tumours—Growths arising outside the kidney are capable of displacing that organ in an equal degree with, or even to a greater extent than, the intrarenal variety (*Fig* 294) Rarely they also cause deformity of the pelvis, but this is by pressure or invasion from without, and not, as in the case of intrarenal growths, by involvement starting in the neighbourhood of the parenchyma

Wilms' Tumour.—This comparatively uncommon tumour is almost, but not entirely, confined to childhood Radiographically it repeats most of the features described for renal carcinomata (hypernephromata), including the elongation, compression (or distension), and displacement of the pelvis and calices. Wilms' tumours do not, however, fungate into the pelvis in the manner so characteristic of 'hypernephromata', well seen in *Fig* 288. *Figs* 295 and 297 show typical effects and in them the contour of the tumour itself is clearly visible and is emphasized by the displacement of the gas-containing colon Wilms' tumours are radio-sensitive and the diminution in size shown in *Figs* 296, 298, 299, when contrasted with their forerunners (*Figs* 295, 297) make clear the advantages to be gained from pre-operative radiotherapy In the writer's experience this treatment has not led to operative difficulty from perirenal adhesion, nor has it delayed wound healing

Tumours of the Renal Pelvis.—There has been a tendency to undervalue pyelography in the diagnosis of renal pelvic tumours, but in the writer's view it is very valuable and not infrequently gives an unmistakable picture of the lesions. The picture varies with

Fig 295 — Wilms' tumour of the right kidney. The rounded outline of the enormous growth which extends to the sacro iliac joint below and well over to the left of the midline is clearly seen. Pelvis is large and spidery with dilatation of upper calix. Ureter displaced. Note particularly the position of the intestines—all pushed over to the *opposite side* including the ascending colon which text books say forms a resonant band in front of a renal tumour!

Fig 296 —Same case as in *Fig* 295. Seven weeks later after irradiation. Note the recovery of the right pelvis which now looks practically normal, also the return of the colon to approximately normal position. Early nephrectomy. Three months later developed chest metastases which disappeared on X ray therapy and have not reappeared. Child well 4½ years after operation.

Fig 297 —Wilms' tumour of left kidney. Large straggling and dilated pelvis. Kidney depressed. Ureter redundant. Intestines displaced as in *Fig* 295. Irradiation followed by elimination of tumour. Nephrectomy. Child well 6¾ years after operation. *N.B.* Has a severe congenital malformation of the right arm.

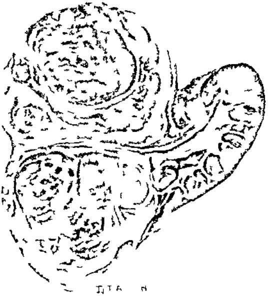


Fig 298 —Kidney from patient in *Fig* 297. Areas of active growth still present which would have continued to grow if the kidney had not been removed.

the position and size of the growth. and a number of situations require description :—

1. When the growth is *very small* it will be unrecognizable by urography. Even so it is capable of bleeding copiously and persistently. though slight hæmorrhages separated by long intervals of freedom are the rule An outstanding instance of a minute papilloma causing hæmaturia persistent for nine weeks was published by Anderson The tiny growth lay hidden in a calix and was so small that it almost eluded detection when the kidney was examined after the operation

Fig 299.—Radiograph of post-operative specimen of case illustrated in *Figs* 295 296 showing the small size of the remaining tumour. Some calcification in lower part of growth

2. *Obstruction* of the urinary channels will sooner or later arise but the time of its onset will vary with the position of the growth Most pyelograms show some grade of dilatation and in doing so give evidence of a pathological process though the cause of the distension is not always clear The pyelectasis varies from minor grades to a hydronephrosis containing several pints of fluid

The usual situation for obstruction is of course the uretero-pelvic junction and here the involvement of the walls may play a

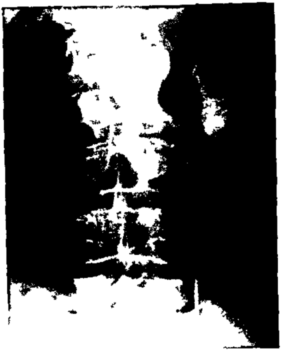


Fig 300 —Retrograde pyelogram Filling de fect of upper cal x which is considerably enlarged Pelvis and remaining calices little altered

Fig 301 —Large papilliferous growth of upper calix of which th pyelogram gives a s ril ingly accurate repre entation

Fiy 3) —I trogra l pyel gram Ur t r e cath t r l n ed ertrar e to th pelvis Som fl i l s ps thro h l it fails to p n trat far Ol vio ly a notall filling l f t l lvis h plac l lo r war ls an l inwar l

Fig 303 Fr rm us k l n C nta r d a pint of l ar rin at p rati n M r sev rely hy lro phrosis th r n w app ars N um ro is papill mata se n f wl l ar packed tightly int th ult Ur t r i illu trat l i Plat IX C (p ge l)

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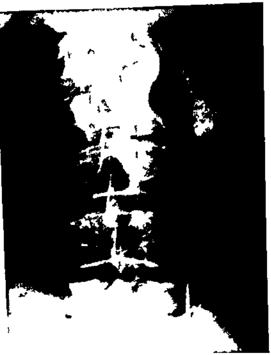


Fig 300 —Petrograd pyelogram Filling defect of upper calix which is considerably enlarged Pelvis and remaining calices little altered

Fig 301 —Large papilliferous growth of upper calix of which the pyelogram gives a strikingly accurate representation

F g 30 —I trogra l pyelogram Ur teric ath t r l r l ntrane to th pelvis Som f il s ps thr u h l it fails to per trate far Ol y l s a n tal l filling d fect I lvis dis pl s l l wi war ls an l inwar ls

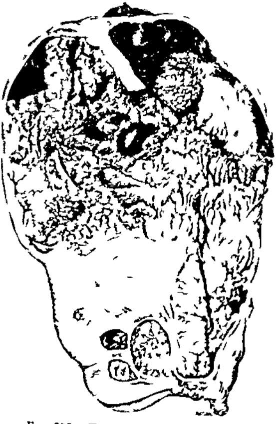


Fig 303 —Enormous ki lney Containe l a pint of cl ar urin at operation M r sev rely hydronephroti than now appear Num rous papill mata some of which ar packed tightly into th o itl t Ur ter is illustrated in *Plat* IX C (pag 19)

major part in its production If the tumour arises at or near this junction obstruction will probably be early and severe, but if the pedicle lies some distance away obstruction must await the production of a frond sufficiently long to cork the renal outlet. Blocking at this position (as also obstruction of the ureter, which will be considered later) will, if severe, prevent catheterization for the making of an ascending pyelogram Obstruction not only to a catheter but also to the introduction of pyelographic solution is very suggestive In cases reviewed in the literature it has been one of the most valuable ways of reaching an accurate diagnosis But even if a catheter will not pass it does not of necessity follow that the channel will be closed to contrast fluids (*Figs* 302 303), which may seep past and prove instructive Obstruction eventually leads to a hydronephrotic and non-functioning kidney and so to absence of any shadow on excretion pyelography In combination, therefore, a stricture and a non-functioning kidney are answerable for the absence of a urogram in a high proportion of pelvic and ureteric growths, for by one the ascending and by the other the descending route is eliminated

Fig 304 —Ascending pyelogram Lowest calyx and part of pelvis cut off Closely simulates parenchymal carcinoma

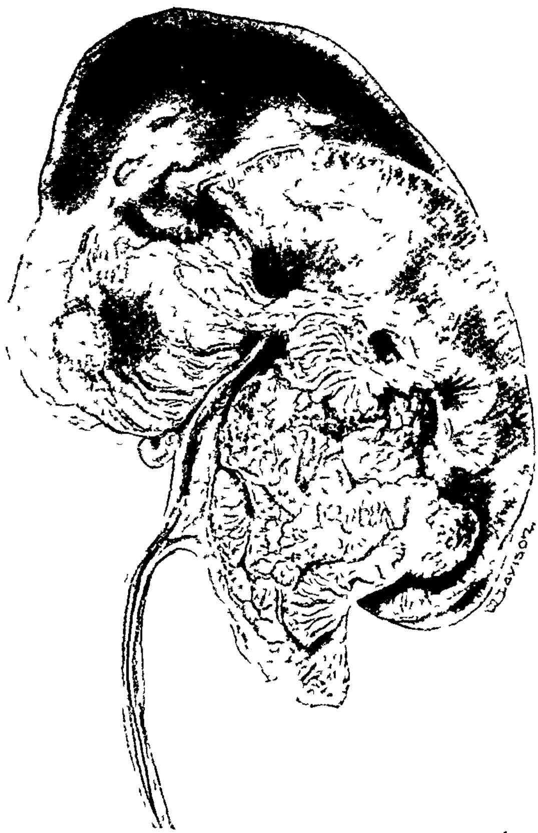


Fig 305 —Large papillary neoplasm of which *Fig* 304 gives a true anatomical impression No apparent extension into the ureter Benign histology Patient's health unsatisfactory and therefore ureterectomy undesirable Four years later recurrence in bladder, etc, as a malignant neoplasm Cf Discussion on bladder papillomata (page 178)

A tumour originating in a calix will quickly fill and blot out partially (*Figs* 300 301, 306 307) or completely (*Figs* 304 305) that calix but if situated at the junction of the pelvis and a major calix it will cause a distension limited to the calix itself (*Figs* 300 301 306 307)

3 *Filling Defects*—Though a tumour growing in the pelvis necessarily encroaches on the lumen of that cavity the filling defect may be unrecognizable because it is so small or because it is lost in the dense shadow of a hydronephrosis

When present, filling defects may or may not be characteristic Some of them especially when the growth abuts on the renal parenchyma or has invaded it, cut off a part of the pelvic outline, usually

Fig 306 —Excretion urogram from a dye worker who had *multiple* primary papillary tumours—in bladder and each kidney Right kidney destroyed Left shows defect at base of upper calix

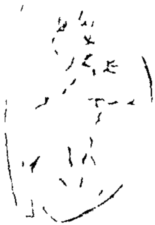


Fig 307 —Left kidney of which the pyelogram is shown in *Fig* 306 having a small rounded papillomatous sessil or subsessil tumour with poorly developed villi situated at point of junction of upper calix with pelvis

one of the poles and such pyelograms are indistinguishable from those caused by a renal carcinoma (hypernephroma) (*Figs* 304 305) though sometimes a crenated margin suggests frond formation

The most valuable and distinctive of all pictures in papillomatous disease of the pelvis is that of a filling defect so separated from the calicine border of the pelvis that we can rest assured that it is not a part of a parenchymal carcinoma In *Fig* 308 an isolated rounded defect is plainly seen and there is an indication of a brush like edge In *Fig* 306 the line of the upper calix is broken by an

object protruding into the cavity from a position where the only likely site of origin is the pelvic wall Filling defects are usually more clearly displayed by ascending than by descending pyelograms, but the latter may nevertheless, be quite satisfactory (*Figs* 306, 308) The possibility that they result from some cause other than a growth must be considered, but the alternatives—especially blood-clots (*Figs* 292, 293, pages 466, 467)—are as a rule transient and can be excluded by obtaining a fresh pyelogram at a later date

Fig 308 —Excretion urogram Centrally placed, rounded filling defect, not making contact with renal parenchyma Margin denticulate Little or no dilatation

When a pelvis is packed with papillomatous material it will, in all probability, allow neither ascending nor descending pyelography It will resist an attempt to introduce solution by a catheter and a few scattered shadows thrown by small amounts of fluid which have penetrated amongst the tightly crowded fronds are all that will be seen (*Fig* 302) A growth of this sort will have compressed, invaded, or otherwise destroyed the kidney substance, so that no excretion pyelogram is possible

A large tumour of the upper pole displaces the rest of the kidney downwards and a bulky lower pole pushes the ureter and pelvis inwards towards or over the spine (*Fig* 302) just as a tumour of the renal parenchyma does

Ureterography for Neoplasms.—A ureteric tumour may itself be the primary or it may be a secondary implant from a papilloma of the pelvis (*Plate IX* page 192) Pelvic papillomata outnumber primary ureteric growths by about ten to one and as the former will, when first seen, have spread to the ureter in approximately 50 per cent of cases it will readily be appreciated that the chances are considerably in favour of a ureteric growth being secondary to a similar lesion in the renal pelvis This is the reason why the treatment of choice for all ureteric growths is by nephro-ureterectomy for it is impossible in most cases to decide where the primary lies *Primary* ureteric growths lead to obstruction at an early time If this is complete retrograde pyelographic media will return down the ureter from the face of the stricture, if incomplete the narrowed portion of the canal

will be displayed together with any proximal dilatation. Irregularities arising from multiple growths may also be outlined. Descending urography will show similar conditions with varying success according to the level of renal function. *Secondary* ureteric implants from a pelvic papilloma rarely, in the writer's experience, produce as much ureteric obstruction as primary growths, but they do distend the lumen by their actual presence, as can be seen in each of the three ureters shown in *Plate IX*, page 192.

When a nephrectomy for a pelvic tumour is followed by a continuation of the bleeding, the bladder being clear, the diagnosis of ureteric implants should be self-evident (*see* page 192) and a ureterectomy may be done confidently without ratification by a ureterogram, though this has been recommended by some authors. A distended ureter with an irregular outline would be shown. A Y-shaped or goblet-shaped filling defect produced by a bulbous growth occupying the upper end of the ureteric stump has been seen on a number of occasions. Scheele states that it is typical of a ureteric tumour. Thomson Walker "tried by passing a catheter up both ureters and working it in the ureter to produce hæmorrhage sufficient for a diagnosis, but failed to obtain blood." To the present writer this appears injurious and supererogatory.

RENAL CALCULUS*

In discussing stone in the ureter it was shown that shadows in the region of that tube supposed to be calculi must in all cases be confirmed either with the assistance of an opaque bougie or by a ureterogram. A similar assertion would not hold good in the case of renal stones. In many instances renal and especially pelvic calculi are easily recognizable by their contour and position and do not require confirmation. Some will have moulded themselves to the shape of the cavity in which they lie, as, for example, pelvic stones which, if of any age, are triangular. The most pronounced instance of a moulded stone is, of course, the stag-horn calculus (*see Fig.* 109, page 189, and *Fig.* 334, page 518). Again the mulberry calculus with its spiculate appearance is unmistakable. Before the

* The radiographic density of a body depends on its resistance to the rays and this increases with the increase of atomic weight of the constituent elements. The following chemical elements enter into the composition of stones, bones, contrast media, as well as calcifications in glands, costal cartilages, etc. Their atomic numbers are shown:—

Hydrogen 1, carbon 6, nitrogen 7, oxygen 8, sodium 11, magnesium 12, phosphorus 15, sulphur 16, potassium 19, calcium 20, bromine 35, iodine 53. (Modified from Shanks, Kerley, and Twining.)

The reason for the transparency of uric acid ($C_5N_4H_4O_3$) and for the opacity of calcium and phosphorus containing stones becomes evident. The high atomic weight of iodine accounts for its value in both kinds of pyelography.

pyelograms are examined straight films taken in inspiration and expiration will have been looked at and compared, and the constancy of, or variation in, the measurements from the renal margin (the lower pole is the most easily picked out) to the suspected shadow will have been carefully noted Valuable though that examination is, there still remain many shadows in the neighbourhood of the kidney which are of uncertain origin and pyelography gives great assistance in their interpretation (*Figs* 309–317), supplying information as to whether the shadow arises within or without the urinary tract, and in the former event indicating the exact situation of the stone and showing whether it is in the parenchyma, a calix, or the pelvis It will demonstrate renal dilatation, if present, and it may also be used to accentuate a stone's shadow when indistinct

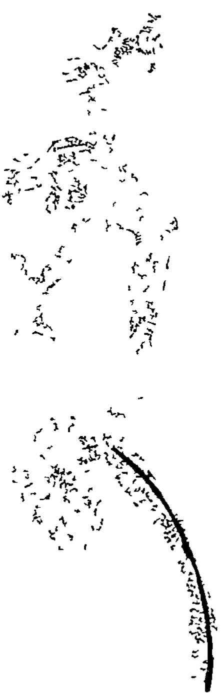


Fig 309 —The mottled shadow of a calcified tuberculous gland was seen on a straight radiograph in a case of renal pain Routine urography showed its relationship to the urinary passages and the probable fixation of the ureter

If originating *outside* the urinary apparatus, the shadow usually results from one of three causes—a calcified tuberculous gland (*Figs* 309, and 201, page 336), cholelithiasis (*Fig* 268, page 452), or calcification in the rib cartilages When the pyelogram is made it will be seen that the two shadows are separate from each other or that they do not completely overlap, or if they do at first coincide, by taking a picture from a different angle they can be dissociated, calculous disease thus being ruled out Most extrarenal shadow-throwing objects lie on a plane anterior to the kidney and a lateral view shows this relationship if the objects are large or of good opacity, if small or less dense they are liable to be lost because of the spine An oblique view appears, for some reason, to be less popular than the lateral one, but is often very instructive and in some cases quite indispensable

If the shadow is that of a *urinary stone* it may lie in the renal pelvis in a calix or in the parenchyma When situated in the *pelvis* the shadow of the solution from whatever point the radiograph is taken overlaps and perhaps completely masks that of the stone When a pyelogram blots out the shadow of a known stone the exact site of that object may remain uncertain. Its position can often be

decided by superimposing the pyelogram, in a viewing box, on the straight film and making bony landmarks coincide The centring of the tube and other details should of course be identical Alternatively, if the catheter is still in position, some of the solution may be withdrawn by a syringe As the pelvic shadow weakens that of the stone comes increasingly into view Sometimes the intravenous pyelogram with its weaker shadows allows the stone to be more easily identified than does an ascending pyelogram A few writers have recommended air distension to indicate the stone's situation but this cannot be too strongly condemned in view of the possibility of air embolism (*see* page 485)

When the stone lies in the pelvis there is generally some distension of that cavity, which may be of minor extent or may have progressed to any grade of hydro or pyo nephrosis (*Figs* 310 312 313 315–317)

Fig 310—Hydronephrosis due to stone blocking the ureteropelvic junction The stone (*a*) has been displaced by the catheter into lowest calix but at operation was at pelvic outlet

If the calculus occupies a *calix* (*Fig* 311) its shadow abuts that of the pyelogram and this relationship is maintained when the photograph is taken at varying angles Distension in this case is limited to the area of kidney drained by the particular calix but as the stone is generally tightly impacted the solution may not reach this distended cavity which would then not be shown on a retrograde pyelogram (*Fig* 312) The calix itself might be represented by the stone's image Occasionally however a communication exists and then a localized hydronephrosis is observed on the pyelogram the stone shadow intervening between this and the shadow of the pelvis proper (*Fig* 311) It is not always realized that gravity is effective within the body A small stone free within the pelvis therefore tends to fall into the most dependent part which, of course, in the upright position is either the lowest calix or the pelvic outlet This accounts for the fact that so many free stones are found in these situations (*Fig* 310) In recumbency the stone may find a new resting place

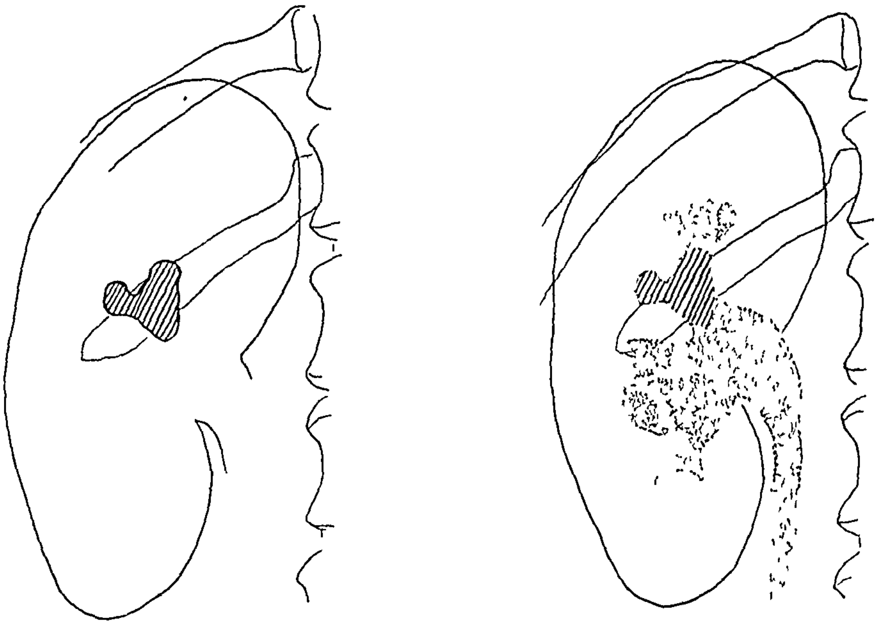
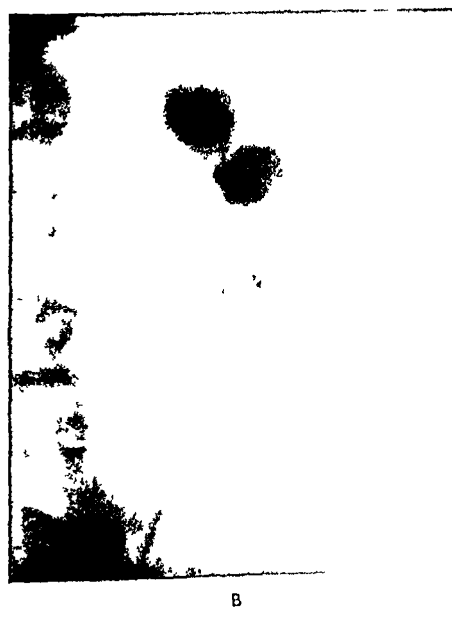


Fig. 311.—A stone shadow seen on a straight radiograph is shown by pyelography to be impacted in the upper major calix. A small cavity in the parenchyma of the upper pole is also displayed. The remainder of the pelvis is normal. Operative approach facilitated.

A

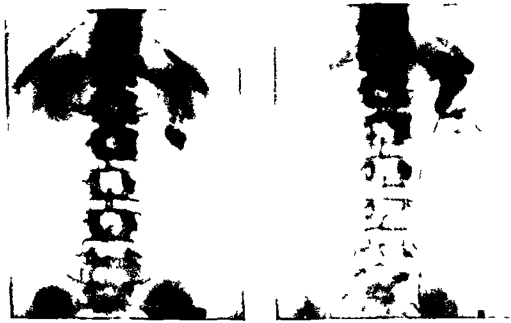


B

Fig. 312.—A, Rounded shadow lying low in renal area. Catheter passes close to it but its tip is seen to have passed 2½ in. beyond it. B, Solution has been injected. It outlines the upper calices only and they are dilated. Stone shadow occupies position of lower calices and no solution has escaped past it to the parenchymal aspect. Stone is therefore impacted in lower calices and this was confirmed at operation.

When the stone is in the *parenchyma* its shadow is separated from that of the pyelogram but lies within the shadow of the renal outline (nephrogram). The distance between the pelvic outline and that of the stone is never great. A parenchymal calculus does not as a rule alter the shape of the pelvis.

An interesting but somewhat rare variety of parenchymal lesion is shown in *Fig.* 318 A. It consists of a rounded cavity filled with small stones lying in the parenchyma and connected with an upper



A B

Fig. 318.—A Large stone impacted in the pelvic area and a small [illegible]. B Several [illegible] which is [illegible] filled. By [illegible] lying A and B the stone is found to extend from the pelvis [illegible] junction [illegible] toward the lower calix [illegible] apparently has hindered [illegible] more than a small quantity of the pyelographic solution from entering the [illegible] of the calix which are relatively faintly seen. The pelvis [illegible] of *Fig.* B ([illegible] pages 441 and 443)

calix. This connection is proved by the fact that pyelographic solution enters from the pelvis (*Fig.* 318 B). The cavity appears to arise as a dilatation around a stone or stones lying in the parenchyma possibly in a tubule and the connection with the pelvis is perhaps by a dilated duct of Bellini.* The stones contained in these cavities are almost invariably multiple and small. Occasionally they have been

* The term hydrocalycosis signifying a dilatation of a calix which has been applied to this condition is a misnomer based on an erroneous conception of its pathology for the calix itself is not affected. It has also been called a diverticulum of a calix and this name is likewise unsuitable.

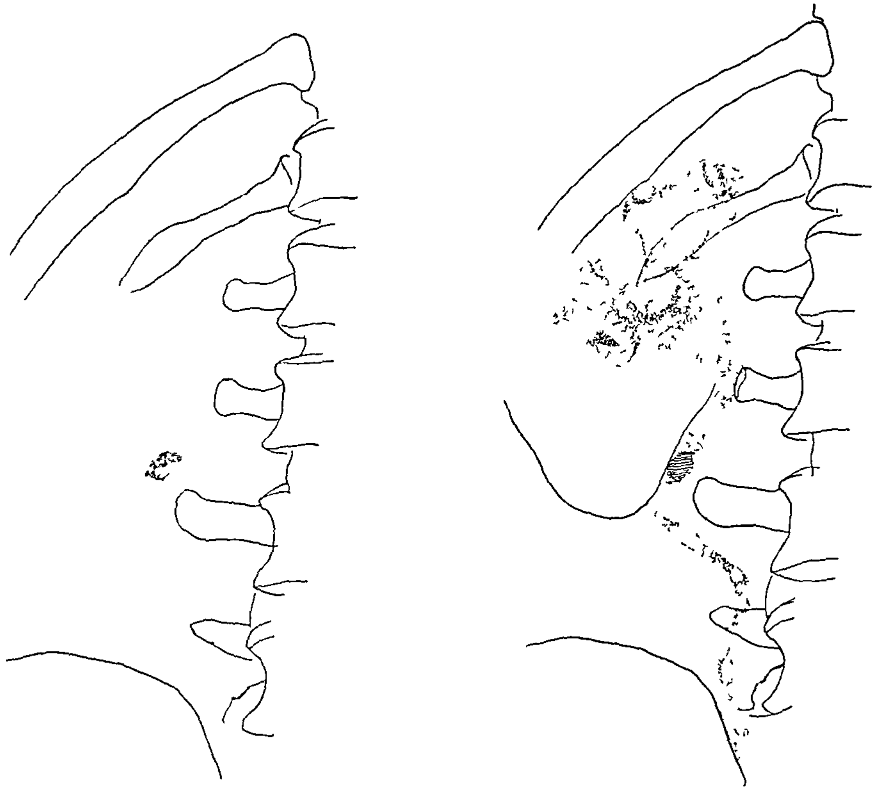


Fig 314.—Suspicious shadow seen on radiography, but diagnosis is uncertain because it is not in the position of the renal pelvis and too oblique for the ureter Urogram gives the explanation Impaction recent Pyelectasis negligible

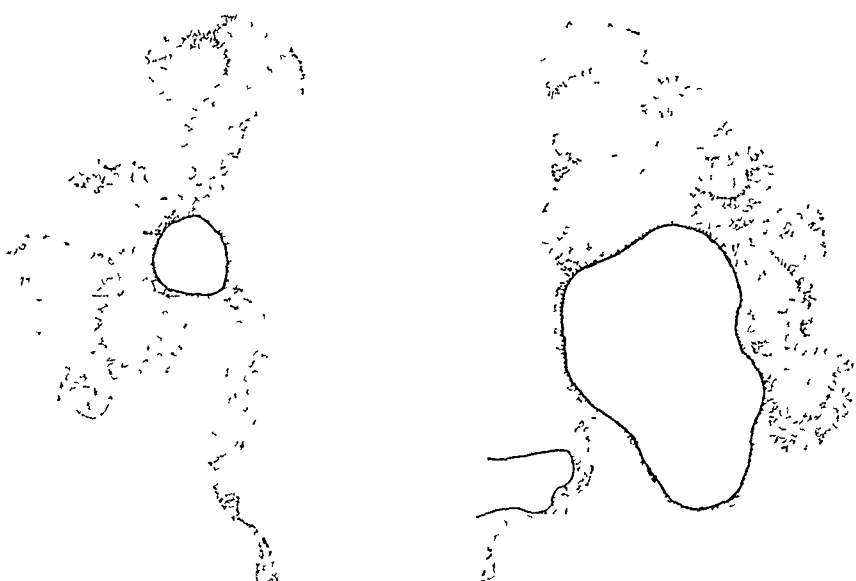


Fig 315 Two tracings from cases in which stones ball valved the renal outlet showing the effects of back pressure

known to escape into the pelvis and ureter, causing colic and a diminution of the number of stones seen radiographically

The situation occupied by the stone as evidenced pyelographically

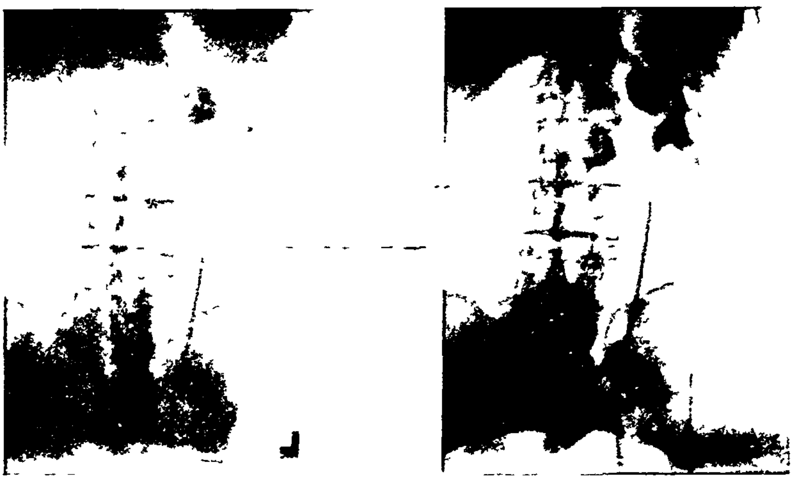
Fig 310 —Numerous stones in a greatly dilated kidney

will be a guide to the most suitable method of operative approach whether this shall be by pyelolithotomy, nephrolithotomy or a combination of these two methods It will also in the case of stones in the parenchyma itself lead to their accurate pre operative localization

Fig 311 —On right side Three stones (dotted outlines) in renal pelvis Moderate dilatation due to stones On left side Large hydronephrosis incompletely filled The rounded shadow is contrast fluid in sump Note the transverse trickle of fluid opposite the lower part of the third lumbar vertebra which indicates the lowest point of the cavity Cystoscopy on this patient showed no indigo carmine from left ureter in twelve minutes Explanation sought by urography Observe how small a quantity of contrast fluid gave adequate knowledge regarding the left kidney This plate shows the importance of a full investigation of the urinary system

and so eliminate unnecessary operative trauma. A stone buried in the parenchyma or impacted in a calix is often astonishingly difficult to find and the search for it can be extremely prolonged and injurious to the kidney. If the stone's precise position is defined beforehand much of the damage can be avoided.

If it is decided to operate on a stone other than a large or obviously fixed stone, no time should be lost after the taking of the radiograph as the stone may change its position in the pelvis or even escape into the ureter (*see Fig* 211, page 349). If delay cannot be avoided a fresh radiograph should be made on the morning of the



A B

Fig 318.—A, A rounded cavity within the parenchyma of the upper pole communicating with the calix by a very narrow channel. Stones have formed in the cavity. B, The retrograde pyelogram shows the position of the stone cavity accurately. Note absence of dilatation of pelvis or calix.

operation for confirmation of the stone's position. When the parenchyma of the kidney is shown by the pyelogram to be extensively destroyed nephrectomy may be forecast, always presuming that the other kidney is proved to be healthy (cf *Fig* 317).

Accentuation of the stone's shadow was described in the chapter on ureteric stone, and the same technique may be adopted with pelvic stones when indistinctly outlined by the X rays (*see* page 345). Sometimes a pelvic stone which throws a weak shadow or none at all may, on pyelography, cause a light patch within the area of the pyelographic shadow.

CHAPTER XXVI

PELVIC RESORPTION

The fact that the pelvic contents especially if under pressure within the pelvis, can be resorbed into the circulation has been known for many years, certainly since the days of Gignon (1856) who was aware of its occurrence in living animals and of the possibility of making pelvic fluids enter the blood vascular system in cadavers

In recent years pelvic resorption has aroused great interest chiefly because of its importance in pyelography,

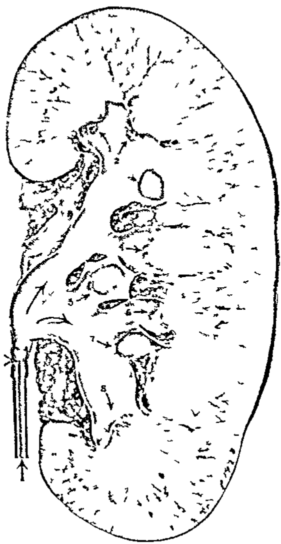


Fig 319 —One half of a human kidney in which pyelovenous backflow has taken place The re are points of rupture in th fornices of every minor calix The injection of the arcuate veins and the stellate veins is shown The extravasation of the ink into the fat of the sinus renalis is quite evident

but also on account of its bearing on other urological subjects such as hydronephrosis It has been known for some time that the contents of a hydronephrosis (the ureter being completely occluded) are not stagnant that there is a perpetual give and take excretion and absorption going on side by side but the mechanism of resorption has remained obscure and it has been assumed that it is a function of the tubules It now appears

probable that various components of the kidney may, under suitable circumstances, undertake this role The lymphatics and probably the tubules can be satisfactorily shown to take up various test substances introduced into the pelvis, but of late much interest has centred on the route, which has been brought into prominence by the work of Hinman and Lee-Brown in America and of Fuchs in Germany, in which regurgitation occurs from the region of the calices directly into the venous system The two first-mentioned authors have given the name 'pyelovenous backflow' to this phenomenon (*Fig* 319) The term has, however, been loosely applied to all varieties of pelvic resorption It should obviously be restricted to the particular variety for which it was originally introduced, and the wider term 'pelvic resorption' should be employed to cover all varieties of regurgitation into the circulation, such as that from the tubules, lymphatics, and mucosa, and not excluding pyelovenous backflow proper It is convenient to describe pyelovenous backflow first, and then to examine some other routes open for pelvic resorption. But it should be emphasized at the outset that there is more than one channel for absorption, that our knowledge of the subject is far from complete, and that considerable confusion still exists about many features

PYELOVENOUS BACKFLOW

HISTORICAL

Our knowledge of backflow started in 1856, and from that time until, say, 1911, when the era of instrumental pyelography began, certain investigators observed and described phenomena which appeared to have little or no practical application and so received but little attention Some of this instructive and interesting early work deserves a brief description

Gignon (1856) is credited with the first experimental observation of pyelovenous backflow On distending the pelvis with fluid he noted that it passed from the kidney pelvis into the veins and he came to the opinion that it passed through preformed venous plexuses which surround the calices In 1863 Ludwig and Zaworykin observed a similar phenomenon and noted that the backflow took place through a small rupture in the mucous membrane of the renal pelvis

In 1883 Ribbert injected small quantities of potassium ferrocyanide into the pelvis of a healthy dog's kidney and ligatured the ureter. In less than an hour he was able to demonstrate that substance in the urine from the other kidney.

In 1891 Poirier, working on human corpses, catheterized the ureters and injected fat into the pelvis The fat was observed to pass into the renal veins In another experiment he injected the

ureters of dogs with water and showed that the water flowed out of the renal vein. "C'était un véritable lavage du rein."

In 1897–8 Lewin undertook similar experiments, employing air for the purpose of injection. The investigation was conducted on living dogs and the animals were found to die of air embolism. Lewin stated that he was unable to discover any injury to the pelvic wall. Yet Marcus, repeating these researches (1904), invariably discovered a rupture generally in the neighbourhood of the minor calices whenever air had entered the venous system. Lewin also recorded the unexpected fact that air introduced into a rabbit's bladder would pass up the ureter, distend the pelvis, and flowing back into the renal vein and vena cava, would cause sudden death. This important experiment undoubtedly explains not a few fatalities resulting from the use of air to distend the bladder before cystotomy. If, as so frequently happens, the ureteric valve mechanism is incompetent, the air pressure may be transmitted to the kidney with rapidly fatal results. Lewin's experiment should serve as a warning against the practice of employing air in bladder distension, and even more so against using it as a pyelographic medium.

In 1894 Tuffier introduced 0.5 c.c. of a weak solution of strychnine into the pelvis of a dog and tied the ureter. No untoward effects were observed until the renal secretion raised the intra-ureteric pressure, when the animal rapidly died of strychnine poisoning. The significance of this experiment becomes more evident when the relationship between the secretory pressure* of the kidney and the pressure at which resorption occurs is considered (*see* page 491).

These and many other experiments of similar significance had been performed before instrumental pyelography—an examination in which the conditions for a clinical repetition of the experiments constantly present themselves—came into general use. A further period of interest in pelvic resorption then became inevitable because of the unsuspected dangers which attended its early use. In the first instance collargol and other silver salts were used as pyelographic media. The fact that these metallic compounds may be very injurious to delicate organs was not foreseen, nor was the importance of maintaining a low intrapelvic pressure appreciated. These two factors were responsible for not a few serious accidents, including some fatalities. It was then discovered that collargol was capable of penetrating into the tubules, lymphatics, and interstitial tissues of the kidney, where its presence caused necrosis. Foci of collargol were also found beneath the capsule, in the perirenal tissues, and in cases

* The secretory pressure is the intrapelvic pressure against which a kidney with a ligatured or otherwise obstructed ureter ceases to secrete.

which came to post-mortem examination, emboli in the liver, lungs, heart, and other viscera were discovered, proving once more that some mechanism existed by which intrapelvic contents could reach the blood-stream These disquieting observations were, however, in keeping with known facts such as those quoted above, and led in the first place to caution in the amount of pressure exerted in injection, and subsequently to the abandonment of silver and other injurious preparations in favour of the halogens. The period of danger from pyelography thus passed, and interest in the subject of renal resorption waned until revived by new work

Hinman and Lee-Brown, who were largely responsible for the awakened interest in pyelovenous backflow, were led to start their observations by the fact that when making celloidin-corrosion preparations of the kidney they found that some of the venous system was filled by an overflow from the pelvis as though a communication existed between them This was a not infrequent occurrence when they were working on post-mortem kidneys.

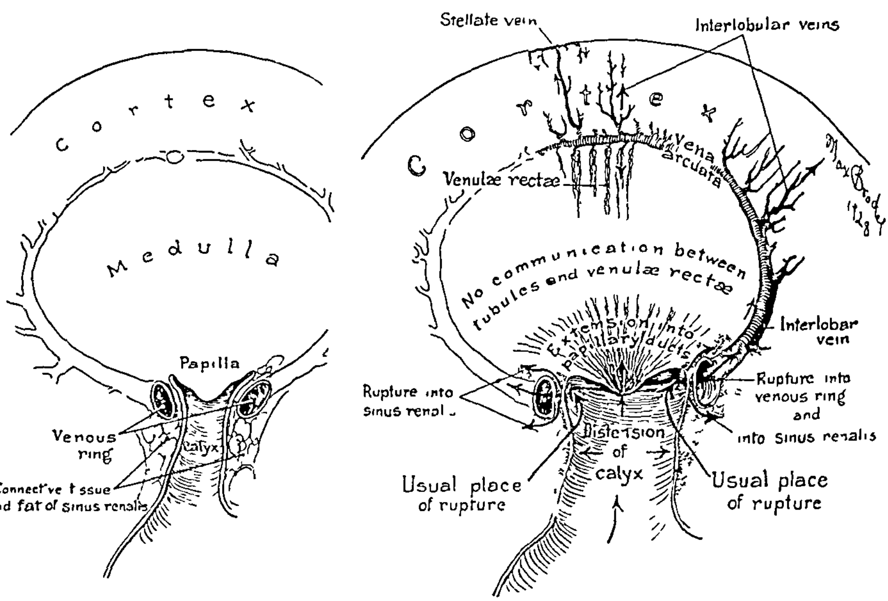


Fig 320 —A schematic drawing illustrating the effects of distension of the calyx and the pathways followed by the injection mass in the production of pyelovenous backflow

ANATOMY

The anatomy of the venous circulation and its relationship to the renal pelvis and the tubules requires a brief description before pyelovenous reflux can be understood

Lying between medulla and cortex (*Fig* 320) there are arcades of veins (arcuate veins) running approximately parallel with the surface of

the kidney and freely communicating with each other These venous arcades receive on their convex surface tributaries from the cortex

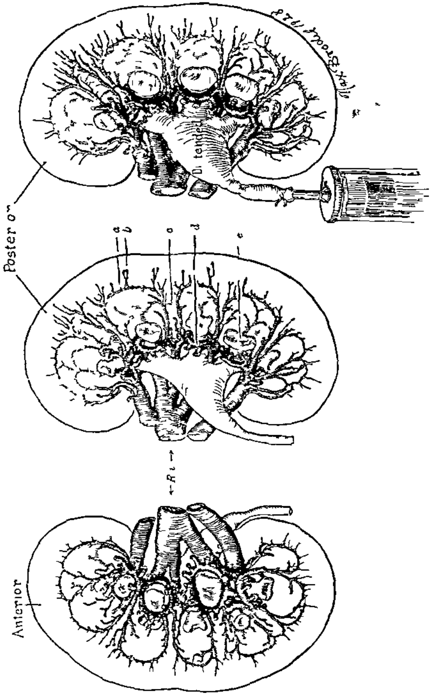


Fig 3 1 —A simplified drawing demonstrating the inner and outer anastomotic venous circulation of the kidney The relation of the inner venous collars to the minor calices is shown with the pelvis undistended and distended *a* Arcuate vein *b* Interlobular vein *c* Interlobar (peripyramidal) veins *d* Venous collar surrounding fornix calicis *e* Cup shaped end of calix into which the papilla is received *Rv* Renal vein

(interlobular veins) which have taken origin in the subcapsular plexus On the concave side open vessels draining the medulla (venae rectae)

which arise in the rich vascular plexuses of the papillæ and which, as they traverse the medulla, are in very intimate relationship with the uriniferous tubules. From the arcuate veins arise the vessels which pass to the exterior of the kidney by way of the hilus Occupying the intervals between the pyramids (columns of Bertini) they are called peripyramidal or interlobar veins A glance at any corrosion preparation of the renal pelvis and veins (*Fig* 321) will show that in emerging from the columns of Bertini the veins follow the line of the pyramid till they approach its apex The apex of the pyramid being surrounded by the calix, the veins continue their course in close apposition to the outer wall of the latter and in intimate structural contact with it In some places they are in almost direct contact with the mucosa of the calices (Hinman). At or about this point the interlobar veins are connected up by transversely running branches which encircle the calix This arrangement produces a second series of venous arcades, small in comparison with those lying at the bases of the pyramids, but important in that they make a rich, thin-walled, venous plexus or collar round the fornix calicis (*Figs* 319–323)

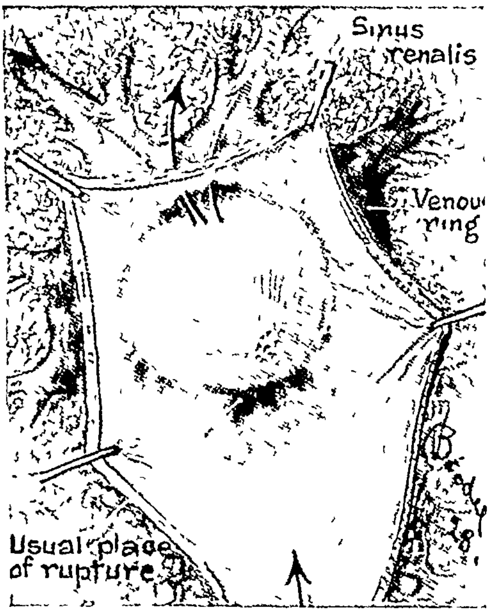


Fig 322 —A minor calix opened to show multiple points of rupture at the margins of the papilla where the pelvis is reflected over the papilla The relation of the point of rupture to the venous ring and the pathway of the injection mass is indicated

The extreme apex of the minor calix—that is, the sharply angulated point where the calix is reflected on to the papilla (fornix calicis)—appears to be structurally the weakest, and therefore the most vulnerable point in the pelvic system It will be easily realized that the papilla, which forms the inner wall of the minor calix, is a solid, unyielding structure, whilst the outer wall of the minor calix lies in soft perirenal fat which lends it practically no support As a sequel to pelvic overdistension tears can, in many experimental specimens be seen following the actual line of insertion of the calix into the papilla (*Fig* 322) When a rupture occurs at this point the fluid may extravasate into the connective tissue of the sinus renalis, but more frequently the tear extends into the vein itself, which is not to be wondered

at when the above described close anatomical relationship existing between the two is considered. That this method of backflow occurs is agreed by most authors though not by all, but to demonstrate the point of leakage is admitted on occasion to be far from easy though such leaks have been satisfactorily displayed in many specimens.

The injection is found to regurgitate up the interlobar veins to the arcuate veins and then proceeds to fill the interlobular and stellate veins and the venulae rectae (*Fig* 323). The fact that the medium proceeds

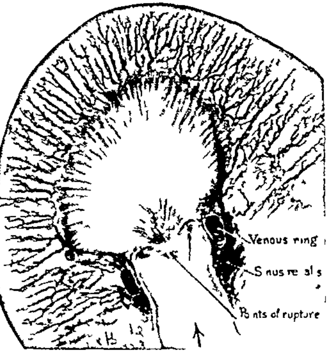


Fig 323.—A longitudinal section through a renal pyramid and minor calix. The relation of the points of rupture to the venous ring and the arcuate veins is seen as well as the injection of the interlobular veins and the venae rectae. The injection of the collecting ducts through the papillary foramina is shown to extend a short distance into the medulla.

from the hilus towards the cortex against the stream of venous blood requires explanation. It is known that pelvic overdistension produces venous engorgement within the kidney. The probable cause of the retrograde route chosen by the pyelographic medium is the obstruction which it encounters at the hilus owing to the pressure of the distended pelvis.

METHODS OF STUDY

Several methods are available for the study of pyelovenous backflow amongst which the following are the principal :—

1 **Corrosion Preparations**.—Celluloid dissolved in acetone may be injected into the vessels of the kidney or into the cavity of the

pelvis. The surrounding tissue is then digested or corroded away with pure hydrochloric acid, leaving the architecture of the filled passages displayed. This procedure has proved itself invaluable for the study of the relationships existing between the component parts of the kidney, any two or more of the hollow tube systems (pelvis, veins, arteries) being filled with suitably coloured celloidin and corroded. It was during anatomical studies of this kind that Fuchs in Vienna and Hinman and Lee-Brown in San Francisco, independently observed the fact that pelvic injections tend to overflow into the venous system, giving a corrosion preparation in which some of the veins are included. This, however, was no new observation, for the fact was well known even in Hyrtl's day. The point of outbranching from the pelvis to the venous system was invariably the fornix calicis.* These findings have been corroborated by numerous subsequent observers. Other injection masses may also be employed for study, such as Indian ink in gelatin (*Fig.* 319, page 483).

2. Animal Experimentation.—In the foregoing short historical section various experiments in which fluids, fat, air, etc., were introduced into the pelvis and flowed out freely from the renal vein have been noticed, and the fact that most, though not all, of the investigators found small ruptures at the apex of the calix has also been recorded. These experiments have been repeated by later investigators with similar results, though some of these workers likewise found difficulty in discovering the point of rupture, and therefore remained unconvinced that the backflow was traumatic.

In doing these experiments it is constantly observed that whilst a certain definite level of pressure is required to initiate the backflow, once that has started a smaller degree of pressure will continue it. Moreover, the piston of the syringe is noted to yield suddenly and a 'soft hissing noise' always follows the collapse of pressure. In Burger's and Fuchs' experiments on living rabbits, air was employed as an injection and the sudden fall of pressure in the kidney pelvis immediately preceded the appearance of air-bubbles in the vena cava. Similarly Fuchs, in a further experiment, studied by means of the X-ray screen the behaviour of a freshly removed kidney when being injected with sodium bromide solution. He watched the pelvis widen and the calices dilate. At a given moment the syringe piston yielded and immediately streak-like shadows appeared in the parenchyma, arising at the point of insertion of the small calices and rapidly spreading

* Fuchs' work for the most part bears out that of Hinman and Lee-Brown, but he has formulated the view that the extravasation occurs primarily into the tissues of the sinus renalis and that it then spreads for a short distance into the kidney between the tubules and the interlobar veins before rupturing into the latter.

so as to display the venous arcades and their tributaries These observations strongly support the view that the ballooned out pelvis actually bursts There appears to be little doubt as to the essentially traumatic mechanism of production of pyelovenous backflow

Experiments to determine at what pressure reflux commences have frequently been made Lindemann (1904) was the first to examine the level and recently it has been studied by Hinman and Lee Brown and others Hinman states that a pressure of 20 mm of mercury is required in a sheep's kidney to obtain slow reflux but that with 30 to 40 mm of Hg a rapid outflow from the renal veins occurred Once established, this flow could be maintained by a relatively slight pressure All these pressures are below the secretory pressure and it might therefore be surmised that if the ureter were simply ligatured the secretory pressure would itself provide sufficient tension to cause a backflow Evidence in support of this view is to be found in Tuffier s experiment (1894) for as stated above he placed in the pelvis a small quantity of strychnine and ligatured the ureter No effects were obvious until the secretory pressure was reached when the animal quickly succumbed to strychnine poisoning In a similar series of experiments Hinman and Vecki imprisoned phenol sulphonephthalein in the ureter The pelvic contents examined periodically showed that the dye gradually disappeared It is therefore argued by them that when the renal outlet is closed excretion goes on until such an increase of the intrapelvic pressure has taken place that conditions favour a pyelovenous backflow

This view is not universally accepted Amongst others Fuchs and Morison may be mentioned as doubting the occurrence of pyelovenous backflow at a pressure below the secretory pressure of the kidney But whatever the mechanism of resorption the fact that rapid removal of pelvic contents occurs cannot be denied In a unilateral retention as shown in the experiment of Ribbert already quoted (page 484) the contents under compression in one kidney pelvis were re excreted by the opposite organ and in a similar experiment carried out by Magoun phthalein confined in a normal pelvis was demonstrated in the urine from the other side within twenty minutes

3 Radiological Evidence —Radiography may bear witness to extravasation either in the living subject or in post mortem specimens

In *post mortem specimens* Lee Brown states that the most spectacular method of demonstrating the phenomenon is by injecting a series of kidneys by way of the ureter with a suspension of barium sulphate and at intervals taking roentgenograms of the kidneys By this means the establishment and development of pyelovenous backflow can be observed and followed (*Figs* 324 325)

A striking experiment carried out by Heinrich is to fill the renal veins with 20 per cent iodipin solution and radiograph them. The pelvis is then distended with air and a further exposure is made Air is found to have entered the veins, where it produces clear, bubble-like lacunæ in the shadow of the iodipin-filled vein.

In some cases the *tubules* only are shown up on the radiograph, but this will be described later (page 494)

In the *living*, and especially in clinical work, pyelovenous back-flow does not give a picture comparable with that of the post-mortem

Fig 324 —Sheep's kidney, in which pyelovenous backflow is advanced but incomplete Made with a barium sulphate suspension at 40 mm Hg pressure

Fig 325 —Complete venous injection without any evidence of tubular injection or extravasation, resulting from pyelovenous backflow at a pressure of 40 mm Hg

organ, partly because of the intervention of other tissues and organs, partly because less opaque media are used but chiefly because the onflow of the circulation quickly carries away the medium and reduces its density *Figs* 326 and 327 are clinical examples of pyelovenous backflow In each case some of the extravasated fluid is probably lying in the fat of the hilus

Hinman maintains that evidence of extravasation obtained on the film during pyelography is caused by fluid which has flowed back within the venous system and that the fornix calicis is the level of entry of the venous system He admits that tubular injection can occur and that in the human kidney and in the kidney of the dog it is more easily produced than it is in the kidney of certain other animals for example the sheep For the most part however, he maintains that tubular penetration is limited to the large terminal collecting tubules (*Figs* 320, 323) The possibility of pyelovenous

regurgitation by way of the medullary tubules into the venæ rectæ of the pyramid or the arcuate veins, as argued by Bird and Moise (*see* page 494) is not completely denied though it is held to be uncommon

Fig 326—Pyelovenous backflow

Fig 327—Severe pyelovenous backflow

OTHER ROUTES OF RESORPTION

It is clear that pyelovenous backflow is a phenomenon occurring in very special circumstances and it is an unsettled question whether it actually occurs at all in normal conditions (*see* page 491) or even when there is total obstruction of the ureter as by a calculus Yet in the case of absolute ureteric blockage we know that there is an interchange between the blood stream and the pelvic contents What alternative routes are available?

I Animal Experimentation—In an attempt to exclude the injury done to the renal pelvis by overdistension and to simulate more closely the natural process Duncan Morison introduced into the pelvis amounts of dye which were known to be well within the pelvic capacity He found that when a dye is introduced into a previously unobstructed pelvis and the ureter is then tied the lymphatics of the pelvis and ureter are the sole route of absorption during the first three or four days The particles of dye are gradually transferred through the thickness of the mucosa musculature and adventitia to the extra mural lymphatics and subsequently to a lymphatic gland lying near

the inferior vena cava From the third or fourth day onwards, however, the dye starts to penetrate the tubular system and will ultimately reach the distal convoluted tubules of the cortex corticis

If, however, before introduction of the dye the ureter has been ligatured for a period of three or more days, conditions are different The dye in these circumstances enters the tubules from the beginning and lymphatic absorption is absent In the convoluted tubules the dye is found not only in the lumen of the tube but actually within and between the epithelial cells At a later time the lymphatics become as active in absorption as the tubules These experiments appear to show that in the absence of overdistension and trauma there are two possible routes of absorption from a totally obstructed pelvis—the tubular and the lymphatic—and that the respective parts played by these alternative routes varies according to whether or not there is some degree of hydronephrosis

"Why is there an initial period of delay before the dye begins to ascend the tubules? Is it due to some natural valve-like action at the tip of the renal papilla, as suggested by Cushny? Longitudinal sections of the normal rabbit's kidney show that the epithelium covering the sides of the pyramid is cuboidal in type and arranged in a single layer (*Fig* 328) As the tip of the papilla is approached this layer becomes elaborated till around the mouths of the papillary ducts it is fully five to eight cells in depth, and almost papillomatous in form With sudden raising of the intrapelvic pressure, as produced by total ureteral obstruction, it may be that this redundant epithelial layer becomes sufficiently compressed, so as to lie in a position over the mouth of the papillary ducts, and thus prevent any regurgitation of the pelvic contents But with continued pelvic distension there is a radial and outward pull on the papilla which would tend to stretch the epithelial layer and remove its obstructing influence from the mouths of the papillary ducts, thus allowing a patent communication for the pelvic contents" (Duncan Morison)

It has been argued by some writers (Bird and Moise) that backflow of pelvic contents passes up the tubular system and from this ruptures through into the veins, perhaps into the venæ rectæ or into the venous arcades in the cortico-medullary area at the point where the tubules cross them These writers have been unable to confirm the occurrence of a calicine rupture and offer this theory as an alternative In answer to this view two counter-arguments may be advanced (1) That it is impossible to imagine that a massive injection of the venous system such as has been repeatedly seen can traverse these minute channels, and (2) That, as shown by Hinman and Lee-Brown, when backflow has been established with a pigmented and therefore easily recognizable solution, the solution is clearly

visible in the cortical area in the venous arcades and in the bases of the pyramids but it does not extend down the pyramids more than a few millimetres (*Figs* 320 323 329) On the other hand the dye in the tubules does not extend up the tubuli colligentes more than a millimetre or two so that there is no meeting place a clear unstained intermediate zone extending over the greater length of the pyramid

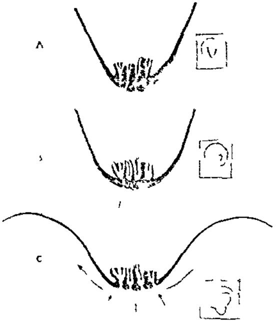


Fig 328 —Diagram representing longitudinal sections of the tip of the renal papilla in three phases A Normal papilla showing greatly thickened layer of epithelium around the mouths of the papillary ducts B With onset of total ureteral obstruction the intrapelvic pressure is raised and compresses the redundant epithelial layer over the mouths of the papillary ducts thus preventing any backflow of the pelvic contents C With advancing hydronephrosis the increasing radial distension by removing the epithelial barrier establishes patency of the papillary ducts and allows free communication between the pelvic contents and that of the tubular system

Fig 329 —Section of a sheep's kidney after pyelovenous backflow had been produced by injecting the ureter with dilute Indian ink at 40 mm Hg The entire venous system of the cortex is injected while only a small area of the medulla in the corticomedullary zone is filled The tubular penetration produced simultaneously is confined to the terminal ends of the collecting tubules at the apex of the pyramid If the dye had gained the venous system as a result of tubular penetration and rupture the veins etc in relation to the penetrated tubules would be filled but the medulla in this area is entirely free from vascular injection

and separating the two areas of pigment The failure of these two areas of injection to make contact appears to be conclusive evidence against this explanation of pyelovenous backflow

2 Radiological Evidence —After filling the pelvis with a radio opaque fluid it is observed that in some *post mortem specimens* (20 per cent Scott) tubular injection is plainly visible on an X ray film (*Fig* 330) It is quite easy to distinguish this from pyelovenous backflow the shadow which it produces on the film

springing from the central depression of the calix and being brush-like or ray-like in appearance. Such rays may be seen at one or more of the calices and they expand fanwise into the corresponding papilla though rarely penetrating far beyond the apices of the papillæ Whether the injection elects to follow the tubules or ruptures into the venous system depends in considerable measure on the kidney used Kidneys from sheep have been much used in experiments and lend themselves to pyelovenous backflow. tubular injection being difficult to produce Conversely in

Fig 330 —Tubular injection of human kidney without evidence of pyelovenous backflow

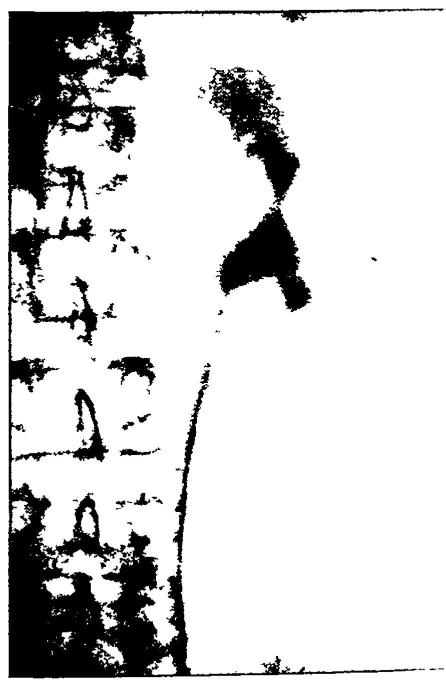


Fig 331 —Tubular injection on a pyelogram Diverging rays springing from centre of a calix

working with kidneys from the pig. cow. etc. the opposite conditions obtain for tubular filling is more easily produced than backflow. The human kidney occupies an intermediate position and either type of filling may be seen. but "any kidney which shows extensive tubular injection seldom shows any pyelovenous backflow. while any kidney which shows free backflow is almost invariably devoid of tubular penetration" (Lee-Brown)

In the *living* similar shadows are occasionally seen in pyelograms (*Fig.* 331)—sheaf-shaped curved pencils which spring from the papilla and diverge as they pass outwards At their origin such shadows may be so densely packed that they present a uniform shadow but

this becomes differentiated as it widens out. Such sheaves may spring from several calices.

More recently fine irregular lines running from the region of the kidney towards the spine have been reported by Wood, Abeshouse, Higham, and others, and are regarded as evidence of pyelolymphatic flow.

3. Corrosion Experiments.—During corrosion experiments it is sometimes found that the menstruum, instead of invading the veins, elects to enter the collecting tubules, but it never penetrates these for more than a short distance. The specimen will then show a very characteristic brush-like protrusion centrally attached in the hollow of the calix.

PRACTICAL APPLICATION

It remains only to point out the practical application of these facts, and for the most part this is sufficiently obvious. The amount of pressure used must be carefully controlled with a view to the exclusion of all chance of pyelovenous backflow (*see* page 438). The solutions we use to-day are fortunately relatively non-toxic, but this cannot excuse incautious overfilling of the renal pelvis. Instrumental pyelography remains one of the most valuable diagnostic agencies at our command and has many advantages over the intravenous method, even if it has also some disadvantages. The somewhat lengthy attempt to review the present state of our knowledge regarding backflow appears to the writer to be justified because it is necessary to a proper understanding of the subject, and without this understanding the dangers of cystoscopic pyelography may not be fully realized.

Resorption is a problem having many facets which do not fall within the scope of our inquiry. It would be fascinating, for example, to pursue the question in its relation to ureteric obstruction combined with sepsis, in which it goes far to explain the severe toxæmias associated with that state. But this and other problems must be left as an exercise for the reader's fancy, or preferably for further original research in this as yet only partially worked out field.

CHAPTER XXVII

EXCRETION UROGRAPHY*

HISTORICAL

The urologist had long hoped that some substance might be found which would be excreted by the kidney and give a shadow on radiography Immediately, indeed, on the heels of the introduction of instrumental pyelography, Voelcker and von Lichtenberg (1905) attempted excretion pyelography by means of the *colloidal heavy metals*, but had to acknowledge failure on account of the great toxicity of these substances A long period then elapsed during which urologists were occupied with the evolution of instrumental pyelography, and it was not until 1923 that Rowntree and Scholl again took up the problem, using *sodium iodide* administered either intravenously or by the mouth. In about one-half of their cases they were successful in visualizing the upper urinary apparatus Nevertheless this compound also proved unsatisfactory, and attempts by several workers to supplement it, either with pneumo-radiography or by compressing the ureters in order to detain and concentrate the excreted solution, were likewise abandoned on various grounds In the succeeding years Graham solved the problem of cholecystography, an achievement which stimulated fresh research It may be remarked, however, in passing, that the two examinations are not comparable, because the renal pelvis does not retain and concentrate its contents as does the gall-bladder Any drug employed must, therefore, be excreted by the kidney in good density and with sufficient rapidity if it is to throw satisfactory radiographic shadows In 1927 Roseno achieved a passing success with *pyelognost*, a drug in which he linked iodine to urea, hoping that excretion would be expedited by the diuretic action of the urea, but, as was the case with the previously mentioned drugs, the iodine proved itself to be too weakly combined, and, being split off within the body, it was undesirably retained and produced symptoms of iodism It thus became evident that a much more stable compound would be required if excretion urography were to be placed on a sound basis

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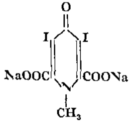
* *Synonyms* Excretion, descending, intravenous, or elimination $\left\{\begin{array}{l}\text{urography}\\\text{pyelography}\end{array}\right.$

Uroselectan.—The discovery of the radiological properties of compounds to which uroselectan belongs came, in a measure fortuitously. Binz was working with the benzene ring in the hope of improving drugs of the salvarsan group for use in syphilis. Iodine was attached at various points to the pyridine nucleus, and some success was registered when an antiseptic capable of controlling streptococcal mastitis in cows was discovered. It was called 'selectan' and was known to be excreted in the bile and in the urine. Working with an allied compound ('selectan neutral') in human beings Lichtwitz was attempting to obtain a cholecystogram. No picture of the gall bladder was obtained but in its place the urinary tract showed up so well that all interest was diverted to it. At this point the clinical side of the inquiry was handed over to von Lichtenberg and Swick, Binz and Raeth continuing the chemical investigation. Seventy-two other substances allied to selectan were synthesized and tried, some because of their large iodine content and others on account of their solubility. Eventually (1929) a compound was chosen as being the best available and was named 'uroselectan'. Uroselectan gave good shadows and proved serviceable but was cumbrous to use in view of the great care required in its preparation and of the large quantity of fluid (50 to 100 c.c.) which had to be injected intravenously. Persistent research by von Lichtenberg and his co-workers culminated (1931) in the introduction of 'uroselectan B', which has superseded the older drug by virtue of the small quantity of fluid required for injection (20 c.c.) and the convenient form in which it is marketed.

Uroselectan B.—Like its predecessor this is a pyridine derivative. Containing 51.5 per cent of iodine in organic combination it is used for intravenous urography as a 75 per cent solution which thus contains 38.5 per cent W/V of iodine. Its formula is:—



Di-sodium salt of 3 : 5-di-iodo-4-pyridone-N-methyl-2 : 6-dicarboxylic acid

(N-methyl-3 : 5-di-iodochelidamic acid)

Its molecular weight is 493. It is very soluble and is conveniently put up in an ampoule sterilized and ready for use. It does not undergo chemical change when kept. In contrast to the original uroselectan only 20 c.c. (15 g.) of uroselectan B are required for injection. The iodine is in close organic combination and uroselectan B passes through the organism without its liberation. Any chance of iodine poisoning is thus precluded. The ampoule as supplied used to

contain invert sugar to render it hypertonic and by this means "the absorption of uroselectan-B by the tissues is hindered with the result that excretion is increased and tolerance improved'. It is now found that uroselectan-B is itself sufficiently hypertonic and the invert sugar has been omitted The hypertonicity of the preparation is largely responsible for its irritating qualities (*see later*)

Uroselectan-B is well tolerated, healthy dogs surviving for seven hours a dose corresponding to twenty times the human dose if the drug is slowly injected. With healthy kidneys it is excreted in good quantity in two to five minutes At this time or during the subsequent forty-five minutes urograms may be made, fifteen or twenty

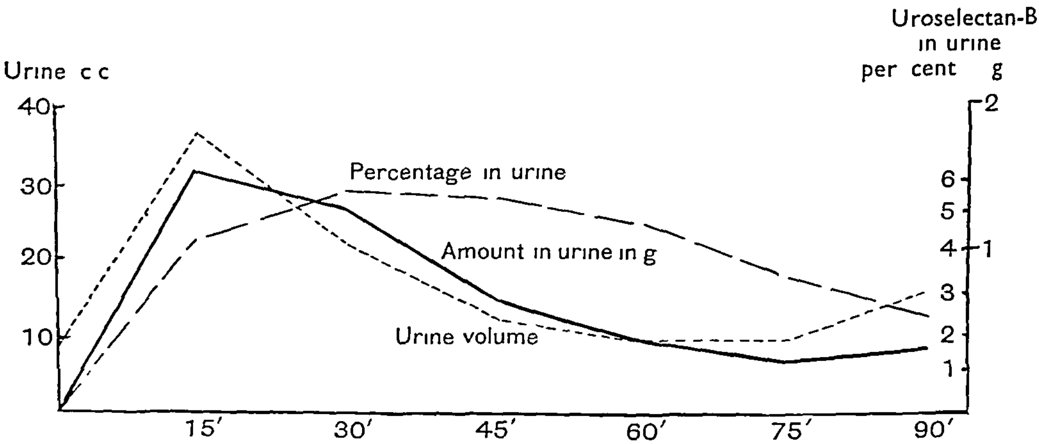


Fig 332 —Graph to show (1) urine volume, (2) percentage of uroselectan-B, and (3) total uroselectan-B in the urine at 15 minutes interval after injection of 0 75 g per kilo, into a bitch weighing 10 kilo (three times the human dose) The diuresis reaches its peak at 15 minutes and rapidly diminishes The percentage rises to a maximum at 30 minutes, remains nearly constant for 30 minutes, and gradually decreases afterwards The total amount found reaches its maximum at 15 minutes and afterwards runs nearly parallel with the urine volume (*After Gardner and Heathcote*)

minutes being the time chosen for the optimum anatomical demonstration of the renal pelvis Von Lichtenberg states that 30 per cent is excreted in the first hour, 12 per cent in the second, and in the succeeding six hours a further 21 8 per cent—63 per cent in the first eight hours The absolute quantity of uroselectan-B found in the urine is greatest in the first fifteen minutes, but during this time it is diluted by the large quantities of urine secreted The actual concentration is highest in the second fifteen minutes. After forty-five minutes the amount excreted is small, although the concentration remains as high as 2 7 per cent after ninety minutes (Gardner and Heathcote—*see also Fig* 332)

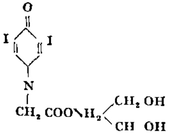
The injection should be given slowly, several minutes being occupied in order to allow admixture with a sufficiency of blood.

Gardner and Heathcote, in the case of the original uroselectan found that with dogs and rabbits death occurred very rapidly if the administration was quickly performed Œdema of the lung was discovered post mortem and was attributed to rapidly induced changes in the osmotic pressure of the blood With uroselectan B also these writers note that the minimum lethal dose depends on the rate of injection, though here failure of respiration and a very low blood pressure appeared to be responsible for the death

During the injection pain in the shoulder may be experienced which is regarded as being due to venous spasm, caused by the irritating properties of uroselectan B If any of the solution escapes into the perivenous tissues severe pain is felt at the site of the injection and some local tissue necrosis may result In a few unfortunate instances a severe injury has been inflicted on the median nerve by the injection of uroselectan B around it It is true that the nerve is in relationship with the median basilic vein posteriorly, but the two structures are separated by the tough deep fascia which in its lower part is reinforced by the bicipital fascia It would seem that only gross ineptitude could stray so far from the proper place as to perforate this firm membrane Nevertheless it has been proposed that that section of the vein which overlies the bicipital fascia should be used but this is a precaution which the present writer has regarded as quite unnecessary the most obvious bit of the vein being the most suitable If extravasation occurs its extent can be determined by taking a radiograph of the part

Perabrodil—Almost immediately after the introduction of uroselectan another excretory body with radio opaque properties was brought forward under the name of abrodil and proved satisfactory in use In 1932 however, it also was superseded by a superior and more convenient substance called perabrodil' (neoskiodan in America) The advantages of perabrodil over its predecessor, abrodil are the small quantity of solution required and the facts that it is better tolerated more rapidly excreted and that its shadows show superior density Also its viscosity is very low and this facilitates introduction

The formula of perabrodil is —



3 5 di iodo 4 pyridone N diethanolamine

It has a molecular weight of 508 and is a white odourless powder containing 49 8 per cent of iodine in firm combination and is unchanged

by boiling For intravenous urography it is issued as a 35 per cent solution which then contains 17 5 per cent of iodine The dose is 7 g, which is supplied in sterile, 20-c c ampoules This relatively small quantity of fluid makes perabrodil easy to handle. The dose administered (7 g) is less than half that of any other excretion compound It can be injected into the circulation rapidly The makers recommend that its introduction should take about forty-five seconds, but Samuel advises the retention of the tourniquet until the injection is complete so that the circulation may be suddenly flooded by the drug with a view to increasing the head of perabrodil in the circulation These recommendations should be compared with those given above for uroselectan-B

That it is well tolerated is shown by the fact that the full human dose may be given to a rabbit of 4½ lb. weight without important ill effects, or that a dose proportionately fifteen times larger than the standard human dose, if given slowly to a dog, is not fatal The drug passes rapidly into the urine, 80 per cent being recoverable within seven to nine hours and a concentration of 5 per cent or more of iodine in the urine being observed. It is excreted unchanged There is a complete absence of evidence of renal irritation in the kidneys of experimental animals, and in the human subject albuminuria is not seen Accidental extravasation around a vein is harmless and painless

On occasion as for instance in childhood or when no vein can be discovered, perabrodil may be injected subcutaneously (*see below*). Local pain is thus less marked with perabrodil than with any of the other drugs used for intravenous urography Pain in the shoulder (vein spasm) and thrombophlebitis are not observed, and general reaction, vomiting, sweating, etc, are uncommon The peak excretion with normal kidneys starts about eight minutes after introduction of the drug and continues for twelve minutes, this period being the best for radiography Good urograms may, however, quite frequently be obtained at four minutes or even earlier The time sequence of perabrodil is slightly quicker than that of uroselectan-B, but both these drugs are more rapid than either of their predecessors

Intravenous perabrodil appears to be a very safe drug in view of the enormous number of uncomplicated injections which have been made, but a few fatalities have been reported and these have mostly occurred in patients with an anaphylactic predisposition Shock, urticaria, and laryngeal and pulmonary œdema have variously been responsible Pendergrass et al sent out a questionnaire which was successful in collecting information about 661,800 cases A total of 26 deaths (additional to 11 previously known) were reported, of which 10 occurred immediately, all of them following perabrodil Sixteen

were delayed and were attributable to the use of one or other drug in the presence of severe renal insufficiency. Several authors have recommended a *preliminary intradermal test with 0.05 c.c. of the solution* given into one arm whilst a control of normal saline is injected into the opposite limb. A weal suggests sensitivity and the advisability of giving a small initial dose of 3 c.c. and awaiting to see if there is any reaction before proceeding to inject the remainder. Major reactions are so very infrequent that a preliminary injection is not customary.

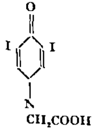
Before the recent war the two solutions which have been described were the only ones available and they were both imported from the continent. At the commencement of the war several British manufacturers started to make these two essential products and a number of trade names were applied to them. Official names have now been given: uroselectan B becoming *iodoxyl* and perabrodil *diodone*. In the description which follows these names will be employed except where reference is made specifically to work earlier than the fresh nomenclature.

Iodoxyl and diodone are available commercially both under their pharmacopœial names and also under a number of proprietary designations. The appended list indicates a variety of these names but no claim is made to include all of them.

Maker	*Iodoxyl*	*Diodone 35 per cent*	*Diodone 50 per cent*
Bayer	—	Perabrodil	Perabrodil Forte
Boots	Urumbrin	Pylumbrin	—
Burroughs Wellcome	Iodoxyl	Diodone	—
Glaxo	Pyelectan	Pyelosil-35	Pyelosil-50
Pharmaceutical Specialities (May & Baker)	Uropac	Uriodone	Uriodone Forte
Schering British	Uroselectan B	—	—
Schering Corporation (U.S.A.)	Neo iopax	—	—
U.S.A. Pharmacopœia	—	Iodopyracet	—
Winthrop Stearns (U.S.A.)	—	Diodrast	Diodrast Compound

Regarding diodone, a few elementary explanatory facts may be acceptable as not all medical men retain sufficient chemical knowledge to understand certain literature issued by manufacturers.

1. Diodone consists of an *acid*: 3 : 5 di iodo 4 pyridone N acetic acid



and a *base* (*see later*). The acid portion carries the iodine which is responsible for the radio-opacity of the ultimate product (*see* foot-note, page 475) The weight of iodine in a given volume (W/V) of the finished product is an essential feature of a compound.

2 To the above acid a base is added, the resulting salt having a considerably higher solubility than the acid. Dissolved in water this salt is the final product received by the profession. Two alternative bases are in use at the present time, viz diethanolamine and diethylamine. The usual 35 per cent solution (17·5 per cent of iodine) contains the diethanolamine salt: the stronger solutions (25 per cent iodine) contain the two salts, sometimes in the proportion of four parts of the last-mentioned salt to one of diethylamine. As yet no final opinion appears possible on the relative merits of these two bases but provisionally the following statements may be made: In conformity with the established principle that mixtures have a higher solubility than single pure substances it is found that higher concentrations can be supplied when these two bodies are combined and certain of the stronger solutions now available result from such mixtures Each of the salts has a similar individual solubility at about 42 per cent weight in volume. The highest level of solubility is reached when they are mixed in equal parts. The question, however, is complicated by the fact that the diethanolamine salt is excreted two or three times more rapidly than the diethylamine salt. If therefore, the latter salt is used there may be undesirable delay in excretion, films having to be exposed later and mixtures perhaps showing protracted elimination. This spread-over may adversely affect the density of the shadow at any given moment and so defeat the objective of the stronger solutions. The clinician must be aware of this cause of delay lest he should misattribute it to faulty renal activity. Black, Powell, and Kemp however, state that the two salts do not differ greatly in respect of iodine clearance and radiographic density The optimum combination of these salts is at present undecided. Another fact is that the stronger concentrations of the diethanolamine salt occasionally solidify in the cold, but, as solution is rapidly restored when they are warmed to blood heat, as is always done anyway before injection, this is of little consequence

3 The method of writing the side chain in diethanolamine has varied in different descriptions and this is naturally puzzling. In some it is written $-CH_2COOH.NH(C_2H_4OH)_2$: in others $-CH_2COONH_2(C_2H_4OH)_2$. The explanation is that the method of combination between the acid and base has remained unsettled, some regarding it as a loose combination, others as a true salt. To-day the general view is that it is in true chemical union and the correct formula for the side chain is therefore, $-CH_2COONH_2(C_2H_4OH)_2$

4 The percentage of iodine may quite obviously be expressed relative to (*a*) the original solid (acid) (*b*) the salt and (*c*) the solution In stating the content of iodine the makers are not always precise on this point Sometimes the claim is made of a 50 per cent content this being true for the solid material but requiring considerable modification in relation to the solution perhaps to 25 per cent

TECHNIQUE OF INJECTION

The preparation of a patient for the X ray examination is more than usually important on account of the weakness of the radiographic shadows Meteorism is a greater source of trouble than it is with retrograde pyelography not only because of the pale images but also because the drugs themselves appear in some way to assist the production of intestinal gases as is shown by the increased amounts present in the later plates On this account some urologists in addition to the usual laxative forbid supper and breakfast prior to intravenous urography and no fluids are allowed for at least twelve hours before the examination This is expected to give more intense concentration within the urinary passages but is not in the writer's opinion necessary and is troublesome to enforce (*see also* page 504) Pitressin may be used to drive off intestinal gases (1 to 1 c c two hours before and a second similar dose half an hour before radiography) Enemata are recommended by some but probably introduce more gas than they evacuate Patients should however when possible be up and about before excretion urography in order to encourage the free discharge of flatus Prior to administration of the drug the bladder is emptied and a preliminary radiograph is obtained The injection is given on the radiographic table an antecubital vein being preferred for the purpose The solution warmed in a water bath to body temperature is introduced with a Record syringe The connection between syringe and needle should be particularly firm as otherwise the needle may be forced off by the considerable pressure required to drive the rather viscid solution through a suitably small bore The needle should lie centrally in the lumen of the vessel its correct position being confirmed by the regurgitation of a few drops of blood into the syringe A film taken at 3 to 5 minutes will register the early phase of excretion and one at 12 to 15 minutes will catch the peak output and show the anatomical details of kidneys which have good function Later films become necessary for damaged and obstructed organs The number and timing of exposures will be varied to suit the needs of the individual case and there is no call to adhere rigidly to a fixed routine

As is common when any hypertonic solution is injected into a vein the patient may have a sensation of general warmth or flushing

These discomforts are, however, of short duration Thirst may be experienced owing to the withdrawal of fluids from the tissues by osmotic action Vomiting, giddiness flushing of the face, and shivering occasionally occurred with the previously used fluids but are rarely seen now and are in any case transitory. The pulse-rate increases by 10 or 15 beats per minute, and the blood-pressure, after a preliminary fall rises 10 or 15 mm. of mercury. Weatherall (1942) investigated the effects on the circulation and, according to him, iodoxyl was found to cause a preliminary depression of the heart (very large doses causing it to stop beating), but this depression passed off probably as a result of coronary vasodilatation Diodone on the other hand improved the heart's output Both drugs caused coronary and general vasodilatation but if they were injected quickly a brief preliminary constriction was observed Heathcote and Gardner point out a noticeable effect of perabrodil on the respiration There is an immediate acceleration of its rhythm together with an increase in its depth, which they attribute to direct stimulation of the respiratory centre Fever has continued in rare instances for a day or two Neither the clotting time nor the sedimentation time of the blood is altered and venous thrombosis does not result Kemp however, says that venous thrombosis following iodoxyl may occur late and that if patients are re-examined after ten or fifteen days a proportion of them will be found to have a painful and perhaps swollen arm with thrombosis extending to the axilla

Authors differ in practice regarding the use of suprapubic compression in order to concentrate the dye Von Lichtenberg is opposed to it because it interferes with the normal motility of the passages Ogier Ward says that the " normal ureters swing freely in the retroperitoneal space and bend themselves into angles which may almost be called kinks Compression tends to fix the ducts and therefore to misrepresent their activities but . it can be of use in the examination of the kidneys themselves". There is little doubt that compression increases the density of the shadows and is thus not to be lightly rejected. A good method suggested by Moore, is to take the first film under compression and the subsequent ones without which plan combines the advantages of both procedures This author, by publishing films exposed alternately with and without compression has conclusively shown the superior density of the former

Comparison between Iodoxyl and Diodone.—There is some evidence that diodone is gaining in favour as compared with iodoxyl The reason for this is probably the absence of injurious irritation which concerns (*a*) the vein into which it is injected—the pain of venospasm is not experienced and thrombosis is not produced, (*b*) the perivenous tissues which are not injured if for any reason

some of the solution escapes into them This is an unavoidable accident on some occasions when the vessels are small and buried in fat but the danger of course varies with the skill of the operator The bland qualities of diodone are shown in its being used for intra muscular and subcutaneous injection in children and other difficult subjects This advantage cannot be claimed for iodoxyl On the other hand iodoxyl probably gives shadows superior to diodone and the introduction of the stronger solutions of the latter drug is an attempt to overcome this drawback Abdominal compression is more necessary with diodone than with iodoxyl and the demerits of compression have been discussed already

Other Routes of Administration—The intravenous route of administration is unquestionably the best in all cases where it is available Inferior routes are the intramuscular subcutaneous and oral but they are used only if the veins prove impossible to enter For the two first mentioned diodone alone is available iodoxyl being painful and injurious For *intramuscular* use the dose may be increased by 50 per cent on that employed intravenously and it is well to divide it into two portions, which are slowly injected into the muscles of the buttock or thigh No dilution is necessary but some workers dilute to half strength Novocain 0 1 per cent can be added though the injection is not unduly painful Absorption is rapid in children and optimum visualization is obtained in about twenty minutes It is somewhat later in adults Films show about 80 to 90 per cent of the concentration given by the intravenous route (Hunt and Popma) If the *subcutaneous* route is chosen diodone can be given into the fat of the pectoral region or axilla It is painless and produces no ill effects except a localized œdema which disappears within twenty four hours It should be diluted to a 7 5 per cent (isotonic) solution Absorption from the subcutaneous tissues is slow that from the muscles being definitely quicker After subcutaneous administration the exposures are made at the end of half an hour three quarters of an hour and later if judged necessary Compression of the lower abdomen should be employed to intensify the urogram as the shadows are faint

Hippuran (sodium ortho iodo hippurate) contains 38 8 per cent of iodine and has been used for intravenous urography but has also been employed for *oral* administration Adults are given 12 g dis solved in 75 c c of syrup children 10 g Satisfactory results have been claimed (Swick), but little success has been achieved in the present writer s experience

FATE OF THE DRUG IN THE BODY

The original uroselectan was shown to be excreted mainly (90 per cent—Swick Heckenbach) by the kidney but in part by the

liver, this latter organ being responsible presumably for the remaining 10 per cent. When there is functional disturbance of both kidneys, the liver takes an additional share in elimination. Some storage is said to take place in the skin (Tourné and Damm). The reasons for avoiding uroselectan in severe bilateral disease of the kidney, especially if complicated by hepatic inadequacy, are sufficiently obvious. Amongst the lower animals it has been shown that the ligation of the renal arteries followed by a normal dose of uroselectan is rapidly fatal, capillary damage being the main cause of death, though in addition there is found a severe injection of the serous membranes, in the transudate from which uroselectan can be found.

Urine.—The output of urine rises sharply in the first two hours succeeding the administration of iodoxyl or diodone, but in spite of this polyuria the specific gravity may increase to 1050, 1060, or even 1080. It then falls to about 1030 and remains there for several hours.* "It is remarkable that the highest specific gravity is usually reached in the third or fourth hour, a time when the greatest concentration of uroselectan is past" (von Lichtenberg). Iodoxyl increases the acidity of the urine. If the renal function is good, the *p*H falls to 5·6 or even 5·2 and returns in the next few hours to the normal. Poor renal function will give a less steep rise in *p*H (Hughes). Albuminuria is frequently noted, but is mild and transitory. With diodone the diuresis is less severe, probably owing to the smaller dosage. It is most marked in the first fifteen minutes. Iodoxyl and diodone are found unaltered in the urine.

The burden imposed on the kidney is a heavy one, yet no parenchymal changes are demonstrated in experimental animals so long as doses corresponding to those used in the human subject are employed, and when excessive doses were administered "there were only very trifling, transient tubular changes, such as swelling and fatty degeneration, while in the glomeruli no changes whatever were observed" (Bronner and Schueller, working with abrodil). Corresponding results were obtained for the original uroselectan by Galbraith and Mackey.

RADIOLOGICAL RESULTS

Excretion urography is, under favourable circumstances, capable of rendering evident on an X-ray film the whole of the urinary apparatus from the renal periphery to the internal urinary meatus.

The *renal parenchyma* is saturated with solution which renders it opaque so that it can be clearly seen on the film (nephrography).

* The height of the specific gravity is related to the molecular weight of the drug.

The kidney's size position relationship to opacities observed on a previous radiograph and the presence of hiatuses in its substance become apparent Nephrography is instructive, and in certain cases may be extremely important but does not always receive the attention which it merits It is one field in which descending urography has definitely proved itself superior to ascending Some years ago similar information was desired of pneumo radiography but this form of investigation fell into disrepute owing to its associated risks and it was discontinued Though easily enough seen the parenchymal shadow is invariably weaker than the pelvic shadow Attempts have been made to strengthen it by withholding fluid for a time before administration of the solution in order to concentrate the latter in the tubules The effects of such abstention are uncertain and indeed some writers maintain that a better shadow is got when the patient takes fluids freely Certainly when renal function tests are to be undertaken simultaneously the fluid intake should not be interfered with If the renal outlet is obstructed the drug collects in the tubules and the parenchyma becomes increasingly obvious

When the kidneys are excreting satisfactorily the *pelvis and ureter* become filled with drug laden urine and their position size and type whether they are normal or diseased and their relationship to other shadows can in favourable circumstances be judged In excretion urography only those portions of the pelvis and ureter which are in diastole contain the shadow throwing reagent those which are in systole do not appear on the radiograph Any section of the tube system from the calix to the bladder may therefore, be missing on a given film but unless pathological will certainly be shown on some subsequent one Slight shadows which appear in good time then come and go and finally disappear in an hour or so indicate normal conditions Shadows which appear late show weakness of secretion Dense and constant shadows are abnormal They suggest good or at least reasonably good, function, combined with obstructed drainage Sometimes excessive peristalsis hurries the contents along so quickly that poor delineation is obtained and the shadow of the healthy side is quite often inferior to that of the diseased When peristalsis is unduly active a cystogram may be obtained with little or no shadow in the upper tract The strength of the renal secretion is nevertheless quite obvious Children exemplify particularly well the results of rapid peristalsis

Excretion is dependent on renal function If *both kidneys* have inferior capabilities the onset of excretion will be delayed The drug is temporarily stored in the organism and not till one three five or more hours have elapsed will it produce a urogram In advanced bilateral disease radiographs taken at twenty four hours may be

[illegible] disease no excretion can be discovered. Where [illegible] is diseased, conditions are different. A kidney which [illegible] a delayed shadow will have little or no drug [illegible] its healthy neighbour has already rid the circula- [illegible] before the damaged organ could act. In the case [illegible] disease, whether unilateral or bilateral, the grade [illegible] will be [illegible] but descending pyelography will [illegible] it will merely show that the kidney [illegible] and instrumental pyelography will be called in to [illegible]

[illegible] after the introduction of the drug a [illegible] as sufficient urine is usually secreted in this [illegible] of these compounds. [illegible] must be studied [illegible] the patient must empty his bladder, as the lower [illegible] are partly or entirely hidden by the shadow of [illegible]

[illegible] OF THE URINARY TRACT

[illegible] supplies a [illegible] of the urinary passages [illegible] instrumentation [illegible] descending pyelography [illegible] physiological [illegible] instrumental [illegible]

[illegible]

INDICATIONS FOR AND CONTRA-INDICATIONS TO EXCRETION UROGRAPHY

Indications.—The chief occasions when excretion urography is indicated are set out below.

1. The advantages of excretion urography are very pronounced where cystoscopy and ureteric catheterization are difficult, impossible or undesirable, and therefore instrumental urography cannot be undertaken or is inadvisable. The causes of such conditions are dealt with on pages 327–33, to which the reader is referred. Descending urography then comes in as a welcome substitute for ascending urography and perhaps also for renal function tests.

2. Some technical matter in the diagnosis may have been overlooked or may have been imperfectly explained by the preceding investigation, or some unsettled question arises when the case is being finally reviewed. It may be possible to clear up such a point by means of excretion urography. In actual practice it is not at all uncommon for this to happen, and a second cystoscopy is circumvented.

3. Frequently the urologist elects to use excretion urography as a way of getting a rapid preliminary survey of a case (*see also* pages 123 and 129). This method is especially valuable when it is not at all certain whether the urinary organs are accountable for the illness, as, for instance, with indefinite abdominal symptoms or a tumour of the upper quadrant of unknown origin. According to the circumstances urography may help to impeach or acquit the urinary system.

4. When the object is to acquire information about the dynamics of the pelvis and ureter (*see* page 510 and Chapter XXVIII).

5. It is valuable as a way of acquiring a cystogram in any patient on whom it is not desirable to pass a catheter. In particular it constitutes an excellent method of showing the residual urine in prostatic disease or urethral stricture. At the time when there is a sufficiency of the drug in the bladder (say half an hour after the injection) the patient is told to urinate, and when he has passed what he can a radiograph will give some idea of the measure of his retention. It thus provides an admirable way of averting that catheterization which is sometimes so hazardous.

6. A heterogeneous group of conditions are suitably subjected to excretion urography, amongst which may be mentioned transplanted or ectopic ureters, fistula of the ureter or pelvis, ruptures of the kidney and urinary troubles in childhood.

Contra-indications.—Excretion urography is contra-indicated in advanced renal insufficiency, especially if complicated by a low hepatic function. If there is any reasonable doubt about the renal capacity the blood urea should be estimated. The writer finds that as a rule a clinical appraisement is sufficient for this purpose, but some surgeons

have the blood-urea examined routinely. Renal function must be severely reduced before it constitutes a contra-indication to intravenous urography, for even a much embarrassed kidney retains a fair measure of excretory power Patients with severe renal infections are intolerant of excretion urography, and it should not be employed in the presence of advanced heart disease, febrile conditions, hyperthyroidism, or an iodine idiosyncrasy Care should be exercised in the use of diodone in allergic states

APPRAISEMENT

Excretion urography has, in the eighteen years since its discovery, firmly established itself as a valuable line of investigation—indeed, it now appears to be an absolutely indispensable one Its field of usefulness is very wide It has nevertheless like many other newcomers, suffered much from the over-enthusiasm of its advocates and is still in process of settling down to find its correct sphere of application The shadows provided by it compare ill with those obtainable with ascending pyelography As a delineator of the shape of the renal pelvis there is no comparison between the two methods This is due partly to the fact that the pelvic cavity is less completely filled and in part to the actual weakness of the excreted solution "Healthy kidneys excrete a 40 per cent uroselectan solution as one containing 5 per cent of iodine and the 20 per cent abrodil solution as a 2 5 per cent iodine containing urine" (Jaki) They both therefore give a much paler shadow than does 13 5 per cent sodium iodide The difference between ascending and descending urography is of course, accentuated by any renal deficiency, and this in its turn is frequently the direct result of the very disease which is under investigation It follows that disappointing results are of frequent occurrence The shadows thrown are so weak in most instances that they can be relied upon to indicate only gross lesions of the kidney or ureter, or alterations in the position, size or shape of the kidney The finer points of architecture require the richer shadows and the better filling provided by instrumental pyelography Minor modifications of the urinary tract cannot be recognized

On the other hand under favourable circumstances excretion urography shows the condition of both sides of the urinary tree and avoids the pain and inconvenience of ascending urography whilst it is further claimed that the shape of the parts is not distorted either by over-distension or by the presence of a catheter Moreover, excretion urography is often available when instrumental urography is for some reason rejected

The recent method does not legitimately threaten to supersede instrumental urography, from which much more exact information

may be gleaned the two methods being complementary rather than antagonistic and usable in conjunction Of great moment however, is the fact that there are many who ignoring not only instrumental pyelography but also cystoscopy and all the other old established urological procedures try to make a full diagnosis by means of excretion urography alone An attempt on the part of the patient to side step the discomforts of cystoscopy is understandable and is one with which we may fully sympathize, yet excretion urography has its proper uses and limitations and it cannot with safety be allowed to trespass beyond them Acquiescence on the side of the practitioner in allowing the examination to be limited to intra venous urography is often not in the patient s true interests even though admittedly it is at times permissible to depend solely thereon

Improper reliance on descending urography is responsible for many mistakes as is borne home daily in any urological practice The incursion of a host of workers untrained in urology and light heartedly willing to give a full diagnosis and opinion solely on the evidence of an X ray film, is pregnant with untold possibilities of disaster Many of the better radiologists are fully alive to this state of affairs and acknowledge the unsatisfactory quality of much of the evidence on which they must perforce base an opinion At the risk of its sounding like an *ex parte* statement it must be unequivocally laid down that the trained urologist—he who is experienced in the after course of urological disease he on whom will devolve the subsequent responsi bility for the case—shall prescribe and indeed is alone competent to judge the measures suitable for the individual case Properly used and severely restricted to its correct sphere intravenous urography is a great asset but if allowed to overstep its proper boundaries it may become a real danger

RENAL FUNCTION TESTING

The elimination of contrast substances introduced into the circu lation depends on renal function and may therefore be used as a test Various methods of judging the power of elimination are available of which the following are the most important (1) *Urography* (2) *Radiography of the drug containing urine* (3) *Recovery of the drug from the urine* (4) *Specific gravity of the urine*—these four are elimination tests, (5) *Estimation of the drug in the circulation*—retention test

1 **Urography**—As the depth of the shadow and the time of its onset depend on the kidneys efficiency excretion urography may be regarded as an indicator of renal function The *depth* of the shadow however is determined by many accessory factors such as the stoutness of the patient variations in radiological technique

apparatus, etc Moreover, the radiograph may be unfortunate in reproducing a period of full systole or that following a peristaltic wave, the system then holding the least possible quantity of the radio-opaque solution, or again the musculature may be hypertonic and peristalsis very active, as it is physiologically in childhood, or pathologically in some irritative lesions (pyelitis, etc) Von Lichtenberg points out that " normally functioning kidneys with normal or hypertonic motility of the urinary tract are least suitable for radiological visualization" Conversely, a shadow of good density may be supplied by a hydronephrotic and therefore not over-efficient kidney, as the secretion collects behind a closed outlet (*see Fig* 335, page 519) Such a picture flatters the powers of the kidney, but as the obstruction is itself generally sufficiently obvious, the depth of the shadow will be discounted As a criterion of renal function the density of a shadow must be accepted with reserve, but it is nevertheless of definite value where for any reason cystoscopy is impossible or contra-indicated

The *time* at which the shadow appears and disappears is also an index of renal function With iodoxyl and with diodone the pelvis should be well displayed in eight minutes, and is generally visible at four minutes or even earlier Excretion should be so nearly finished after one hour that no shadows remain with either of these compounds A late onset, diminished intensity, a prolonged period of excretion, and defective filling generally indicate an impoverished renal function. Probably a late onset is more significant than a poor shadow in view of the uncertainty of the renal shadow, and, moreover the observation of onset excludes errors arising from the presence of known or unsuspected stagnation

A *shapely pelvis* and a sufficiency of parenchyma (nephrography) are also points to be taken into account, for they, at least, show if the kidney is morphologically intact

2. Radiography of the Drug-containing Urine.—The drug-containing urine may be collected in test-tubes and radiographed alongside a standard solution, the relative depth of its shadow indicating its concentration

3. Recovery of the Drug from the Urine.—Iodoxyl may be precipitated from the urine by acidulation with a concentrated mineral acid (hydrochloric or nitric) With excess of acid the drug goes into solution again, so that the greatest precipitate is obtained by titration with acid and alkali alternately The precipitate is then filtered off, dried and weighed The weight of iodoxyl excreted in a unit of time is used as a test of renal function and proves itself a satisfactory indicator An investigation of renal function, carried out on these lines by Wade and Band with the original uroselectan shows that excretion with normal kidneys rises steeply and reaches its peak between one and a half and three hours after injection, to fall gradually until none, or only

a trace, is observable at the end of twenty four hours A graph modified from their work (*Fig* 333) shows the reaction of normal kidneys and contrasts therewith the response of a patient suffering from chronic nephritis in which a "uniform low excretion of uroselectan was found" For the recovery of diodone *see below* under RETENTION TEST

4 The Specific Gravity of the Urine—This is greatly increased after the administration of any of these drugs a fact which was observed (for uroselectan) by von Lichtenberg in his first publication Specimens obtained and tested at stated intervals show a rise which may reach 1050 1060 and occasionally more during the first hour This increase in specific gravity might be used as an index of renal function It is however accompanied by a very marked polyuria which must obviously lower the reading To take the level reached by the specific gravity and ignore the polyuria would be fallacious as the diuresis is very inconstant Boeminghaus recommends therefore that the figure representing in cubic centimetres the quantity of urine produced in one hour be multiplied by the last two figures of the specific gravity the resultant being an index figure representing function as for example —

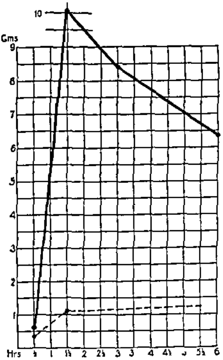


Fig 333 —Two graphs combined from Wade and Band Normal uroselectan excretion curve ———— Chronic nephritis excretion curve - - - -

	FIRST HOUR OUTPUT	SPECIFIC GRAVITY	FUNCTION INDEX
Patient A	435 c c	1022	9570
Patient B	200 c c	1042	8400
Patient C	730 c c	1018	13 140

The above are elimination tests Of them Number 1 shows the separate performance of each kidney Numbers 2 3 and 4 concern only total renal function unless indeed the urine has been obtained by ureteric catheterization But to avoid catheterization is one of the advantages of excretion urography and if that is to be undertaken renal function may just as well be estimated by the older and better established means

5. Estimation of the Drug in the Circulation (Retention Test).—The blood, which immediately after the injection is flooded with uroselectan, shows a very steep fall in the curve during the first two hours and a subsequent gentler fall, till, at the end of four hours, no drug should be found in the circulation if the kidneys are healthy (Tourné and Damm) An estimation at this time will therefore constitute a blood-retention test A remainder of 0 5 g of uroselectan four hours after the injection indicates some minor renal disability, whilst a higher quantity shows severer damage (von Lichtenberg) For estimating the diodone iodine in fluids such as the blood and urine the methods of White and Rolf and of Alpert are available Findlay et al , using the former test estimate that in healthy subjects 45 per cent of the diodone should be excreted within half an hour, and the rates correspond closely with the clearance of urea They consider that the estimation of this product constitutes a satisfactory test of renal function

The results of function testing by these substances appear for the most part to run parallel with other function tests, though the two kidneys do not always give identical results even when both are presumably healthy As the excretion of this group of drugs occurs principally at the glomerulus, disease involving that structure is reflected more certainly in renal function testing than disease of the tubules (Hughes and Peterfi) Surgical disease falls principally on the tubules Wade considers that the primary value of excretion urography is its service as a test of function, and states that "as a means of delineating the form and capacity of the renal pelvis and thereby demonstrating the morbid anatomy of any lesion which may be present it is unreliable"

EXCRETION UROGRAPHY IN SPECIAL CONDITIONS

In the section on instrumental urography a description of the value of that procedure in individual diseases was given (pages 444–482) and there is no necessity to repeat this matter The majority of what was said holds good for excretion urography, but in some fields descending urography enjoys special value or applicability, whilst in others it has special limitations The following remarks are meant to draw attention to these differences and should be read in conjunction with the corresponding matter in the preceding section A few observations made under the heading 'Appraisement' (page 512) also bear on the relative value of the two methods, and if re-read should help to complete the picture

Congenital Malformations.—Maldevelopment of the kidneys and ureters may be diagnosed by intravenous urography. The position,

number, and shape of the misformed organs become manifest from this examination always granted that the kidneys are functioning Malformations are diagnosable by ascending pyelography in most instances and if so with greater precision than by descending pyelography, yet there are not a few cases in which a ureter cannot be catheterized owing to disease or misplacement and then the intravenous method is invaluable (*see also* Chapter XXIII)

In *ectopia vesica* I have employed descending urography to determine the contour of the renal pelvis and the function of the kidney both before and also after operation When the ureter has been implanted into the intestine for ectopia (as also for vesical growths etc) cystoscopic pyelography becomes impossible and descending pyelography is the only available resort and is a useful means for renal function testing and for finding out whether the organs have suffered dilatation as a result of the implantation Prior to the introduction of intravenous urography we relied on an impression of the patient s general health together with a nitrogen retention test to form some estimate of the renal condition but it nevertheless remained mostly a matter of surmise Concrete radiological evidence of the anatomical and physiological effect that implantation has had on the kidney is most acceptable to the surgeon even though it will in not a few cases show dilatation which in some may be severe and not altogether flattering

After ureteric implantation the bowel becomes the reservoir for urine and accumulation of the drug within it shows the way it is stored Grey Turner and Saint found that it appears in the rectum within half an hour and gradually ascends into the pelvic colon In six hours it may be seen at the splenic flexure and not infrequently has found its way back to the cæcum The films show that not only the rectum but the remaining portion of the large bowel can and does act as a reservoir for urine and they explain at once why these patients can allow such lengthy intervals to elapse between evacuations '

Stone in the Kidney—Excretion pyelography in renal lithiasis provides valuable information which concerns (1) The relationship of suspected shadows to the kidney (2) The presence and degree of dilatation (3) The function of the affected kidney (4) The condition of the second kidney

1 The relationship of suspected shadows to the kidney is judged in the way described for instrumental pyelography on page 476 The weakness of the excretion shadow is sometimes advantageous in that it allows the stronger image of the calculus to be recognized in its midst where the greater intensity of an instrumental pyelogram would have completely eclipsed it For the same reason the late plates in which the radio opaque fluid is clearing away from the pelvis may

prove to be the most instructive In these late plates some of the contrast fluid may be retained on the stone and deepen its shadow.

When a stone is impacted at the ureteropelvic outlet or elsewhere it may be impossible to obtain a distension pyelogram because neither catheter nor reagent will pass the obstruction An excretion pyelogram overcomes this difficulty because the opaque fluid is secreted on the opposite (renal) side of the stone The same fact obtains when a calculus blocks a calix, the localized hydronephrosis which is cut off by the stone cannot be displayed by ascending pyelography but becomes evident by descending pyelography

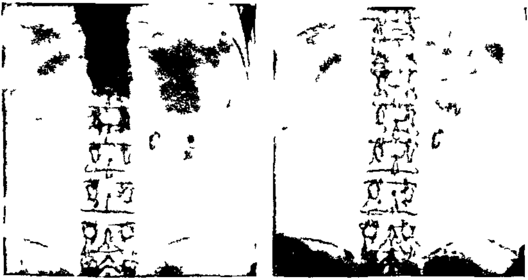
A large dendritic stone filling the whole pelvis and the calices may give a radiograph that is almost indistinguishable from a pyelogram and it is curiously easy to be misled into thinking that one is examining a pyelogram (*Fig* 334) Also when looking at a urogram it is possible to attribute the whole shadow to the radio-opaque solution, and I have known the presence of a stone overlooked in this way Routine radiography before urography would have prevented this mistake

Fig 334 —Bilateral dendritic renal calculi imitating a pyelogram This patient had had stones removed from the right kidney on two occasions and from the left on one during the preceding three or four years

2 Pyelectasis has been dealt with in part above It usually results from the blockage of the whole or a part of the pelvis by the stone Where infection is present pyelectasis may be of the inflammatory type Not rarely it is to be seen in the absence of both these causes and is then presumably a manifestation of pelvic atony

3 The function of the affected kidney may be judged by the manner in which it excretes the dye Stagnation however, is very liable to flatter its capacity by accumulating the dye (*Fig* 335) It is quite common to find the image of an obstructed kidney more dense than that of its completely healthy neighbour The period of onset should be noted and will provide a better representation of the kidney's true capacity Nevertheless good shadows

even though produced with the aid of obstruction, promise some recovery in the capacity of the kidney after removal of the stone, and clinical experience bears out this expectation. This evaluation of the kidney may be contrasted with the findings of the carmine test. In the case of a kidney of the variety under discussion indigo carmine is retained in the pelvis and chromocystoscopy will give an unduly pessimistic picture of the kidney's capacity. But if a catheter



A B

Fig 335.—Stone blocking left ureteropelvic outlet. Exposed at 6 minutes and 30 minutes respectively. The figures illustrate the accumulation of contrast solution behind the stone, its increase in density with the passage of time, and show how a dilated and injured kidney may, when obstructed, provide a dense shadow much denser than that of the healthy but freely draining neighbour (see right kidney A)

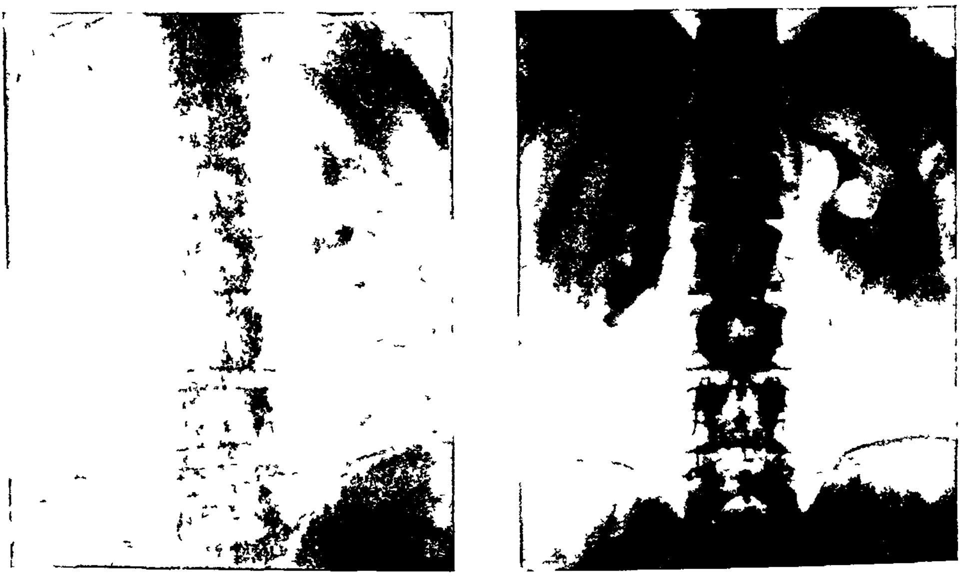
can be introduced into the pelvis a strongly stained specimen of urine will be obtained. After the removal of the stone a corrected view of the renal capacity is given by chromocystoscopy.

4. The presence, health and function of the other kidney may be demonstrated. Excretion pyelography has discovered pyelectasis in this second organ (*Fig* 317, page 481) with a frequency not previously known, which suggests that the condition on each side is the remainder of a foregoing pyelonephritis, and perhaps that the stone is a secondary phenomenon arising from infection and stagnation.

Polycystic Disease of the Kidney and Renal Tumours.—Excretion urography is particularly unsatisfactory for either of these diseases. The plates leave uncertainty in the mind of the investigator because small sequestered shadows appear lying where the renal parenchyma might have been expected and having no certain signification. A pelvis which has been displaced by a polar growth may on occasion be usefully outlined and correctly interpreted, and sometimes, though

rarely, the outline of the tumour itself is permeated with the drug and can be recognized as a rounded, mottled area, but for the most part, excretion pyelography is a failure In many cases, indeed, the renal substance has been so extensively destroyed that there is no output of the dye But, as will be recalled, cystoscopy is *de rigueur* in the investigation of symptomless hæmaturia (page 165) in order to trace the origin of the bleeding, and since cystoscopy is being done in any case an ascending pyelogram is the obvious procedure

Urological Conditions in Childhood.—Disease of the upper urinary tract in childhood is an important field for the application of these



A B

Fig 336 —Girl, aged 19, right renal colic A, Excretion urogram shows severe pyelectasis on the right side but good function Left side beautiful normal outline At operation the ureteropelvic junction was strapped by band containing vessels which were divided and dissected away B shows recovery of pelvis almost to the normal

newer methods because of the difficulties experienced in instrumental pyelography The dose for a child of 7 years is half that given to an adult, and for one of 2 a quarter the full dose The veins in childhood are fairly obvious and the lumen is easily found with a fine needle If the child is alarmed a brief anæsthesia with ethyl chloride is induced (Ogier Ward) Longer anæsthesia is undesirable because the respiratory movements spoil the radiograph

Exposure to the rays need only be of short duration in children owing to their small size and this in some measure overcomes the difficulty of persuading a child to stop breathing Gas in the colon is more troublesome than it is in the adult, especially if the child has

been confined to bed Aperients and enemata only aggravate the trouble and the best remedy is where possible, to have the child up and about before the injection though the drug itself is largely responsible for the production of the flatulence The liver appears to excrete more of the reagent in children than in adults, and this taken with the great activity and rapid emptying of pelvis and ureter in childhood may be responsible for some indifferent results Parenteral administration is frequently useful in children as has already been indicated

Assessment of Operation Results—Following conservative surgery on the urinary tract—plastic operations or division of blood vessels for hydronephroses ureteric neo implantation etc —a tolerably accurate idea of the results is obtainable by excretion urography (*Fig* 336 A and B)

Pregnancy (*Fig* 337)—It has been known for some time that there is in late pregnancy an almost constant widening of the ureter and pelvis and frequently some dilatation even in the earlier months The study of this interesting physiological phenomenon received a fresh impetus by the introduction of excretion urography a procedure which appears to be without ill effects either to mother or child The changes are found to be most marked in the second half of pregnancy—that is from the fifth month onwards—and the dilatation becomes more pronounced as pregnancy advances A hundred women who were beyond the half way were submitted to excretion urography by Schumacher and dilatation of both sides was seen in 83 The remaining 17 all showed involvement of one or other side the right being affected 15 times the left only twice In the later stages the changes are more pronounced in primiparæ When dilatation is really severe the right side is implicated three or four times more frequently than the left and primiparæ more often than multiparæ If dilatation is discovered in the first half of gestation it is less severe and is more likely to be observed in multiparæ The ureter is affected more than the pelvis and the pelvis proper more than the calices

The Ureter—It is the lumbar section of the ureter which suffers principally the part below the pelvic brim only rarely sharing in the dilatation In half the patients past the fifth month the upper ureter has the thickness of a finger and in many of these it equals the breadth of two thumbs In a few it runs a direct course but the tube in addition to being dilated is also elongated and in order to accommodate its additional length it is displaced externally and becomes tortuous and may be severely twisted and kinked Sometimes the radiographic silhouettes of these deformities appear as right angles acute angles or even double hair pin bends yet they comparatively rarely interfere with the onflow of opaque solutions and for this reason

the condition has been regarded rather as a hypotonia than an obstruction by pressure Pronounced bends and kinks are confined to the top four or five inches of the ureter and are definitely more prevalent on the right side In late pregnancy, kinks are seen in about four-fifths of all patients examined and at that time there is also a backward displacement in many If a series of films relating to this condition is

Fig 337 —Excretion urogram on an eight months pregnant woman The fœtal skeleton is seen The right upper urinary tract is moderately dilated The ureteric shadow reaches a breadth of ½ in at one point Owing to increase in length of the tube it becomes twisted and the silhouette has the appearance of being kinked Early but definite clubbing of calices is observed The left pelvis is normal, but there is some deviation of the ureter with slight dilatation at the level of the iliac crest on this side

examined much variety will be found to exist amongst them, and this is true not only as between different ureters, but the same ureter examined at different times may show considerable variations, this last fact being perhaps related to the position of the fœtus

The pelvis shares the dilatation to some degree, but the calices are not usually much involved till the last month or two The carmine test shows deterioration of function in comparison with non-pregnant

healthy women and the delay may be pronounced in the presence of infection The pyelitis of pregnancy does not accentuate the radiographic evidences of dilatation either in the ureter or in the pelvis but it materially slows down the rate of recovery after parturition whilst in not a few infected cases the pyelectasis persists

Ureteric catheterization is very effective in the treatment of infection during pregnancy In many cases it is followed by a prompt fall in temperature and pulse and by cessation of pain The catheter may be left in position for several days

Involution of the Urinary Tract after Delivery—This has been studied by Mengert and Lee who have shown that in twenty four hours the urinary organs take a surprisingly large step in the direction of normality and that within nine or eleven days of parturition the recovery is complete in healthy women In primiparæ the recovery is for the most part slower than in multiparæ and it is noticeably retarded by pyelitis

Menstruation—In normal menstruation the upper urinary tract undergoes temporary dilatation comparable with that witnessed in pregnancy but of less degree It can be displayed by intravenous urography in about 66 per cent of women and is especially pronounced in dysmenorrhœa Saitz believes that this type of dysmenorrhœa is ureteric in origin and that it can be relieved by ureteric catheterization He has christened it ureteric dysmenorrhœa

CHAPTER XXVIII

PYELOSCOPY. CINEMATOGRAPHIC PYELOGRAPHY

PYELOSCOPY

PYELOSCOPY is the name given to the visualization and examination of the renal pelvis and ureter on a fluoroscopic screen It aims, through detecting the filling and emptying of the urinary cavities, at an extension of our knowledge of their physiology and pathology. It portrays peristalsis, motility, spasm, and inefficient drainage, and though much more difficult of accomplishment, it attempts to play the same role in renal diagnosis as the screening of the stomach following a barium meal plays in gastric diagnosis Pyeloscopy was first employed by Menges in 1912 and was described by him in 1918. An important monograph by Legueu, Fey, and Truchot appeared in 1927.

TECHNIQUE

A ureteric catheter having been introduced, the room is darkened and a considerable time (five to fifteen minutes) is allowed to elapse so that the eye may adapt itself to detecting the minutiæ of the filled pelvis. The patient lies on his face, the X-ray tube being below the couch Sodium iodide (30 per cent) and iodipin have been used as contrast fluids in the past, but iodoxyl and diodone will probably displace them in the future As the fluid flows into the pelvis it is seen to fill that structure and then to outline the calices, usually one calix after another undergoing distension As soon as the cavity is satisfactorily filled, the catheter is withdrawn and the process of emptying begins A normal renal pelvis ejects about 1 c c per minute (Hryntschak) Five minutes or more—even up to fifteen—may be required for its complete evacuation, but these longer times are usually evidences of disease A normal pelvis empties more rapidly in the upright than in the recumbent position Evacuation appears to start with the calices which have been likened to the heart's auricles (Herbst) These do not act synchronously, but individually empty their contents into the main pelvic cavity (ventricle), which in turn undergoes systole, displacing a portion of its contents downwards into the ureter Occasionally a portion of the pelvic contents is returned to a calix The ureteric spindle is at first but

an appendix (bulbus ureteris—Legueu) to the pelvic shadow. As the spindle elongates, however, its apex passes down, and when a certain distance (usually about 10 to 15 cm.) has been traversed the connection with the pelvic shadow is broken, the ureteric contents passing on steadily till their apex reaches the bladder, into which the whole is discharged. The speed of the whole wave is about 20 to 30 mm. per second (Engelmann). A period of diastole ensues. It spreads from above downwards, the same order being followed as that which the systolic wave adopted. The pelvis is in full diastole shortly after the ureteric spindle has separated. Diastole exceeds systole in duration.

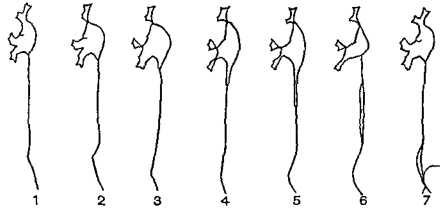


Fig. 338.—Cycle of changes observed in the pelvis and ureter. 1. Pelvis and calices in diastole, ureter empty. 2. Upper calix contracted and expelling its contents into pelvis, ureter empty. 3. Upper and middle calices contracted and expelling contents into pelvis, upper ureter relaxing. 4. All calices contracted, expelling contents into pelvis, upper ureter more relaxed. 5. All calices and pelvis contracting, expelling portion of contents into ureter. 6. All calices and pelvis completely contracted (completed systole), ureteral shuttle moving downward in streak-like manner. 7. Diastole of calices and pelvis. Ureteral streak passing into bladder. Pelvis ready to start a fresh cycle. (*Re-drawn from Herbst.*)

The cycle is repeated at intervals of about ten to thirty seconds (*Fig.* 338).

By inspecting the inflow of iodine one can almost completely exclude the possibility of over-distension of the pelvis. That the usual pyelographic routine which accepts the patient's sensations as a guide to the degree of filling often misleads can be shown by pyeloscopy. Thus pain may be elicited in sensitive individuals as soon as the first few drops of fluid enter the pelvis, and the pelvis is then seen to pass into immediate spasm. The spasm is apparently the cause of the pain, but it soon subsides and the injection may then be cautiously continued. Normal pelves react more violently to this irritation than pathological ones, but if over-dilatation occurs in either of these the pelvic sphincter may go into spasm and retention results, the patient experiencing severe pain. This last observation appears

to confute the theory that if a small catheter is used for pyelography over-distension is avoided, for the sphincteric contraction grips the catheter and prevents the pelvis draining itself into the ureter. Again, if the catheter tip lies in a calix, distension may be limited to the calix and the pain is then immediate. Withdrawal of the catheter until its apex occupies the pelvis proper corrects this cause of pain A similar effect is produced when the catheter end does not reach to the pelvis. In this event it is the ureter which becomes inflated beyond its capacity The return of the catheter to its correct position is less easy in this case, and the best available method is to lower the patient's head to obtain assistance from gravity and to inject very slowly Legueu says that pyeloscopy properly carried out causes no pain whatsoever X-ray films are exposed periodically to make the record of the findings permanent.

ADVANTAGES AND DISADVANTAGES OF PYELOSCOPY

Pyeloscopy should not be employed to displace pyelography, but merely to supplement it However, from the preceding description of how the waves of contraction constantly sweep over the renal pelvis and ureter it will be appreciated that the record obtained on a pyelogram is that of a series of states superimposed upon one another and not a picture of any single momentary condition In general, the information acquired by pyeloscopy runs parallel with that obtained by pyelography, but in addition several vital or dymamic phenomena are witnessed In inflammatory states of the renal pelvis the wave of contraction is more sluggish than in the healthy condition and is provocative of less pain When the contraction does take place, however, it is usually quite strong Pyeloscopy may be expected to solve some problems in inefficient renal drainage, especially those relating to faulty dynamics of the upper urinary apparatus Legueu claims that it is possible to exhibit hyperactivity or stagnation, retention, and spasm, and in many cases to locate the exact site of the fault or obstruction Spasm of the pelvic sphincter can be witnessed when the patient experiences colic, and the two are conterminous. It is particularly helpful in inflammatory states, early hydronephrosis and movable kidney In small hydronephroses contraction is sluggish and evacuation takes twenty to thirty-five minutes In large hydronephroses the pocket is motionless, there is no contraction and no undulation of its margins An affected kidney may have outlines which are normal but the motility of its walls be severely reduced or absent

The formation of the ureteric spindle has been described It must be carefully examined and the progress of the shuttle-shaped streak along the ureteral canal will prove interesting because it can

reveal important variations in the ureteral mechanism Its progress may be checked and several questions immediately arise Is the obstruction always at the same place? Is it complete or partial? Can a stone be seen? Watch the shuttle attentively as it approaches the obstacle to its progress The apex impinges on it and is held up The oncoming wave drives the rest of the spindle forward and the ureter above it is momentarily ballooned The opaque fluid recoils from the face of the obstruction and may be thrown back in its entirety to the pelvis or proximal ureter, or if the blockage is only partial the slow seepage of fluid alongside together with the disappearance of the overlying accumulation will be remarked A second wave may arrive before the first is cleared but in such cases the whole of the tube system above the block is distended there is no isolated spindle only the undulatory movement caused by the peristaltic wave is seen

Over filled or constantly filled ureters are always a sign of faulty renal drainage whether the cause be neuromuscular inflammatory or obstructive As a rough generalization it may be laid down that the neuromuscular variety is variable in position the inflamed ureter is lazy and infrequent in its contractions and more or less uniformly filled over fairly long reaches whilst an organic obstruction is constant in position and the hypertrophied ureter above it contracts vigorously and often

Jona and Flecker have made a pyeloscopic study of the action of various drugs on the renal pelvis They have demonstrated that atropine relaxes the musculature and leads to painful retention, whilst strychnine morphine, eserine and pituitrin produce contractions and relieve the pain caused by atropine Histamine was shown to cause relaxation with vasodilatation and a fall of blood pressure ergot a relaxation followed by a prolonged contraction

Instructive as pyeloscopy has proved itself it suffers from several important disadvantages —

1 The presence of a foreign body in the ureter which is known to excite efforts at expulsion

2 The unnatural filling of the cavities with a more or less irritating fluid Overfilling may occur and lead to artificial pictures

3 The difficulty of satisfactorily visualizing fluoroscopically such fine cavities as the renal pelvis and ureter

4 The impossibility of mentally registering impressions of conditions which are constantly and quickly changing and which are in any case highly complex

5 The failure to obtain a permanent graphic record of the cycle of change which each calyx undergoes

CINEMATOGRAPHIC PYELOGRAPHY

Jarré has taken a further step forward in producing serial roentgenographic films with modified cinematography An average series consists of twenty individual pyelograms with an exposure time of from a half to one and a half seconds, and intervals of a half to three-quarters of a second Usually it is found possible to take five or six successive pyelograms without interruption for breathing Excretion pyelography was used almost entirely and the images are thus freed from the artificial conditions produced by the presence of a catheter or the introduction of media from below The physiological integrity of the tract is therefore preserved with striking accuracy

Only two minor criticisms can be levelled against this method (1) The fact that all intravenous media cause a high diuresis, (2) The comparative weakness of the images The former is probably not very important as it merely leads to acceleration of the cycle Partly to overcome the second difficulty, but also to produce a connected record, the films are " carefully traced under a reducing lens with a sharply pointed pencil and photographed " Much experimental work has been done on the peristalsis and dynamics of the ureter, but little on that of the pelvis The presence of muscular tissue in the calices, at the fornix calicis, and even on the papillæ has been known ever since Henle's classical paper This muscular provision postulates contractility in these structures, but hitherto no such contractility had been demonstrated Jarré's figures show the periodical filling and the apparently motor evacuation of the individual calices and he has been able to show modification (hyperactivity or sluggishness, according to the circumstances) in inflammatory or other diseased states

APPENDIX

The following notes on pyuria, haematuria and frequency are presented as a skeleton framework on which a *precystoscopic* evaluation of these signs and symptoms

PYURIA, THREE GLASS TEST

Patient arrives with bladder full to its ind…
Glasses must be *scrupulously* clean. No dust. No … at the base. Best examined whilst warm and befo… had time to settle, therefore as soon as possible a…

A turbid urine may result from Phosphates, Carbonates, Urat…
Differentiate as follows —

Cloudiness caused by	*Heat*	[illegible]
Phosphates	Cloudiness increased	Clear
Carbonates	No change	Clears [illegible]
Urates	Clears	No change
Pus	Cloudiness stationary or increased	No change

Use only small portion of one specimen as remainder is wanted for the laboratory.

In the *male*

Glass 1.—Quantity passed should vary accordingly to bladder capacity as judged by the patient's frequency, say between 3 and 3 hours. Every purulent focus from kidney (both sides of the urinary tree) to meatus (+ prepuce) may add quota of pus to this glass.

Glass 2.—All pus from anterior and posterior urethra has been swept away in 1. Therefore pus found in 2 is from *above the internal sphincter*.

Glass 3.—Follows prostatic massage (be sure condition is non tuberculous before massaging). Patient assumes knee elbow position and contents expressed centripetally from prostate and vesicle. Bead may appear at the meatus and if so is collected on a micro scopic slide for microscopy. Patient rises and urinates.

Interpretation of Three-glass Test.—

If 1	contains pus		It may come from any part of the urinary tree
If 1	contains pus	and 2 none	Pus is of urethral origin (occasionally preputial)
If 1 and 2	contain pus	in equal quantities	Pus is from above the internal sphincter
If 1 and 2	contain pus	but 1 more than 2	Pus is urethral + from above the sphincter, probably cystitis, but copious pus from posterior urethritis overflows into the bladder rather than into the anterior urethra
If 1 and 2	contain pus	but 2 more than 1	Some relatively clear urine is being decanted from the bladder during the first stages and then urine from a purulent sump follows

Really copious pus is invariably urinary and not genital

Large coagula of pus come from the bladder—mucus + pus

Note on Pus and Threads in First Glass—

1 Fluid pus from urethra appears as uniform turbidity in first glass (probably early gonorrhœa)

2 If threads are bright yellow, granular, size of a comma to a millet seed, and sink quickly to bottom of glass, they are rich in pus and infective Always examine for threads with glass between eye and a good light and agitate the glass

3 Small comma-shaped threads which are yellow and sink quickly are from mouths of prostatic ducts and/or Littré follicles

4 Grey flakes, semi-transparent and floating *to top* of glass, are largely epithelial, probably non-infective but suggest an old urethritis

Flakes in glass 1 (only) suggest a urethritis (active or healed)

This examination avoids unhappy questions about past infections and resultant falsehoods There is usually sufficient exfoliation from the surface of a stricture to produce a thread

Third Glass—Contains flocculent material from prostate and vesicles

In health grey, opalescent

In infection tends to be yellowish and opaque but it is unsafe to draw firm deductions without microscope

Pus in glass 3 is often associated with flakes in glass 1 and then probably both represent an old venereal infection Pus from prostate

and vesicles may also be found in association with pyuria arising from upper tract and then generally non venereal

Send all three glasses to pathologist for full study Label them 1 2 3 A B Glass 2 may be regarded as a catheter specimen and catheterization (which always carries some risk of infecting the bladder) is avoided

In the *female* glass tests are less instructive than in the male The urethral orifice and vulva having been carefully sponged and a small tampon inserted in the lower vagina a preliminary glass is taken for the purpose of sweeping the urethra clear Even in health the female urethra and genitalia add much sediment to the urine and a naked eye inspection of this glass is almost valueless The second glass gives a good index of the state of the bladder contents though less reliance is placed on this than on the corresponding glass in the male

HÆMATURIA

Hæmaturia if a symptom is blood *visible* in the urine

Very common symptom because many parts of the urinary organs are highly vascular—e g kidney and trigone In some diseases (e g, growths acute cystitis) it is characteristic In almost all diseases it is an occasional symptom

Anatomical Origin of Bleeding —Can be roughly located by Two glass test *but* in hæmaturia a *single* point bleeds (exception hæmorrhagic nephritis)—cf pyuria where infection spreads upwards and/or downwards and therefore *many parts* may be suppurating

ANTERIOR URETHRA —Drips away in intervals between micturition not a true hæmaturia—urethrorrhagia but first gush of urine clears the pipe and therefore blood is present in first glass Present in subsequent glasses if hæmorrhage is active but in small amounts

Causes

(*a*) Instrumentation is the most common—if slight not necessarily unskilful if severe generally unskilful

(*b*) Other traumata from without—blows kicks etc from within—spiculated stones foreign bodies

(*c*) Acute urethritis (very rarely)

HÆMATURIA PROPER arises from any part behind *compressor urethra* May be (*a*) Initial (*b*) Terminal (*c*) Total

NOTE Hæmaturia comes and goes and often is not present at the time of the consultation but it is an impressive symptom and so the patient can generally state how it is related to micturition

Therefore, we more often than not rely on the patient's statement Cf pyuria (i) Does not suddenly cease and return and therefore can be diagnosed by Three-glass test without consulting patient. (ii) Patient probably does not know its relationship to micturition

A INITIAL HÆMATURIA —Less common than total or terminal—arises in (1) posterior urethra (2) neck of bladder

Posterior Urethra —Causes —

1 Acute posterior urethritis, quite common Cf acute anterior urethritis, where hæmorrhage is very rare

2 Stone impacted

3 From veins of mucosa overlying benign prostatic hypertrophy.

N B Contrary to popular belief, a prostatic carcinoma practically never bleeds at all but (late) ulcerates into the bladder and then hæmaturia is total

Bladder —Rare *Example*, from fronds of a papilloma caught in the meatus

NOTE Capacity of posterior urethra is about 2–3 c.c It is bounded above by internal sphincter and below by external sphincter The latter is the stronger Therefore when bleeding exceeds 2 or 3 c c blood flows back into the bladder and gives a total hæmaturia

B TERMINAL HÆMATURIA —Important Can confidently assert that the blood is vesical in origin Mental picture is of the bladder in the last stage of its contraction expressing blood from pathological mucosa

Causes —

1 *Acute Cystitis* —Onset sudden Associated with acute pain (especially terminal) severe frequency day and night, strangury, fever, pyuria

Hæmaturia disappears within 36 to 48 hours

Picture is characteristic, therefore do not cystoscope It may damage the bladder and tells you nothing Send home to bed, etc (*See* page 91) Cystoscope if fails to respond to treatment

RULE Hæmaturia generally demands cystoscopy—Two exceptions —(*a*) Acute Cystitis (*b*) Nephritis (non-suppurative)

2 *Vesical Stone* —Probably associated with vesical pain which has preceded it for some months Increased by jolting Usually not copious

3 *Vesical Growths* —These cause total hæmaturia much more often than a terminal or initial hæmaturia

Characteristics —

a Rarely any other symptom in the *early* stages Old adage "Symptomless hæmaturia means growth of the urinary tract and probably of the bladder"

b Intermittency—at first lasts 2 or 3 days—absent for weeks or months—returns Attacks become more frequent, severe and prolonged till bleeding becomes continuous Long intervals suggest benign growth Continuous or quasi continuous bleeding from the first onset suggests malignancy

C Total Hæmaturia —Blood present in *all* 3 glasses may be 'Medical' or Surgical'

1 *Medical* —Nephritis embolus ulcerative endocarditis purpura, etc These must be excluded Usually easy sometimes very difficult

General Features Intimately mixed Colour dirty brown 'smoky' due to change of hæmoglobin to hæmatin or methæmoglobin by action of acid urine

Exceptions occur and too much reliance must not be placed on these appearances

2 *Surgical* —*General Features* It is spontaneous abundant intermittent or capricious often painless not influenced by rest or movement total' in 3 glass test

Points favouring 'surgical' type —

a Other Symptoms or signs —Pain referable to the tract *for example* in loin penis testicle etc

Changes in micturition—frequency, difficulty, etc

b Copiousness of Hæmaturia —Severe bleeding is probably surgical ('medical' bleeding rarely reaches the severity we see daily in surgery)

Clotting—almost certain that it is 'surgical' type

NOTE 1 Severe bleeding is more likely to be from the bladder than upper urinary tract especially if not associated with renal colic

NOTE 2 Severest grades of bleeding occur from growths

Facts suggesting clots originating in the kidney —

a Clot colic Rarely severe Many times less severe than stone colic and clinically there is little difficulty in recognizing this difference

b Worm like clots which get their shape from the ureter Sometimes many inches long Not easily recognized unless urine is poured out on a flat dish Suspect a renal neoplasm Not as helpful a sign as text books suggest

c Bladder very easily washes clear of blood at cystoscopy (really an instrumental sign)

FREQUENCY OF MICTURITION

Normal—waking hours—5 or 6 times Males oftener than females All nocturnal micturition is pathological except in infancy

Increased frequency may be non urinary or urinary

PRINTED IN GREAT BRITAIN BY JOHN WRIGHT AND SONS LTD., THE STONEBRIDGE PRESS, BRISTOL